DEPARTMENT OF THE INTERIOR

National Park Service

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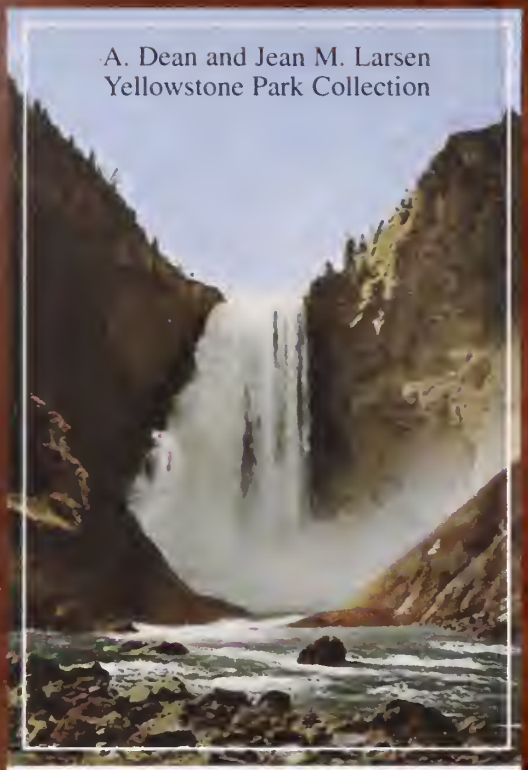
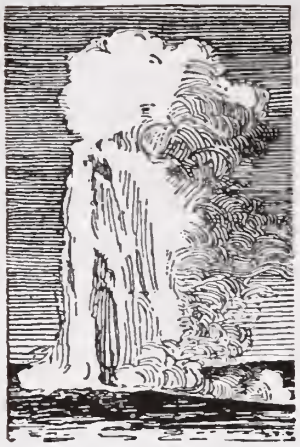
RANGER NATURALISTS MANUAL

Yellowstone National Park

VII





YELLOWSTONE
NATIONAL PARK

Ron & Jane Lerner Collection

BRIGHAM YOUNG UNIVERSITY

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Twelve copies of the Ranger Naturalists Manual are distributed as follows. They are to be returned to the Park Superintendent at the close of the season for revisions and additions for next year:--

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Superintendent Horace M Albright

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TABLE OF CONTENTS *** RANGER NATURALIST'S MANUAL



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TABLE OF CONTENTS --- NATURE NATURALISTS JOURNAL,
(continued)

# PREFACE

## RANGER NATURALISTS' MANUAL

## Yellowstone National Park

## 1926

This collection of typewritten copies of various lectures, guide-talks and special articles pertaining to Yellowstone National Park, it is hoped will be of real service to those assigned to guiding, lecturing, information and museum duty, in avoiding conflicting statements and too much repitition; also in getting the service under way promptly at the beginning of the season.

In the past the criticism has been made that rangers occasionally "talk down" to their audiences, make sarcastic replies, and unintentionally give the impression that they think themselves superior to their audiences, but, as a whole, they have done their work in such an admirable way as to be a real credit to the National Park Service and to themselves.

We have a two-fold mission. We represent the Secretary of the Interior and the National Park Service as hosts to the People of the World. Every tourist is our personal guest. And we are the faculty of the biggest summer school of nature study on earth,- a school of 150,000 pupils! Our glorious task is, in John Muir's words, "To entice people to look at Nature's lovliness". Our statements must be exact and cautious beyond possibility of question. And we mustn't hesitate to show our boundless delight in the marvelous and beautiful world we have to interpret.

Preface — Ranger Naturalists' Manual

This compilation is the result of a great amount of work of many present and former members of the staff, and while it is only a start, we feel that it is suggestive of the possibilities of the important task of acquainting guests with the history, the science and the beauties of Yellowstone National Park, of which they and we are the owners.

Much literature in the park is available; and the cooperation of the other members of the staff may be had for the asking, in solving any problems that may arise in the work.

Your cooperation is solicited in contributing one or more articles for the amplification of this collection, and in suggesting improvements, which will be greatly appreciated.

Approved;

H. M. Albright, Superintendent.

Signed;

Henry S. Conard.

Dr. H. S. Conard.

THE NATIONAL PARK SERVICE ***** NATIONAL ASPECTS

Director Stephen T. Mather.

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The National Park Service which will celebrate its tenth birthday in 1926, is not only one of the youngest, but one of the busiest Government bureaus.

In addition to administering 19 national parks, scattered from far off Hawaii to the coast of Maine, and from Alaska to southern California and Arizona, there are 32 national monuments to be protected.

Many scientific and technical problems are involved in addition to the wealth of administrative and fiscal details that require constant attention.

The principal functions of the National Park Service are to preserve these areas in as nearly as possible, their natural condition, and at the same time to make them accessible to the people as playgrounds, areas of recreation, and museums of nature.

This involves a nicely balanced policy of conservation, with the development of public utilities such as hotels, camps and transportation systems.

One of the first considerations in making the park accessible, is the construction of adequate roads and trails, to bear the concen-

trated traffic from a number of good approach highways. To insure their construction in accordance with the best engineering practices, the cooperation of the Bureau of Public Roads has been enlisted on the major road projects. The National Park Service has its own staff of civil engineers to maintain park roads, construct trails and handle many local engineering problems.

Serious landscape problems are involved, as the Service will not tolerate sacrificing scenic features to expediency in road construction, or in the placing of the various buildings of the public utility operators, or those of the Government itself.

Last year over two million people visited the national parks and monuments, and still more are expected in 1926/.

To provide comfortable accomodations for all of these people, guard their health, protect them from accident, furnish them entertainment and educational facilities, and at the same time to protect the natural beauty of the parks and objects of scientific, historic, or prehistoric interest in these reservations is a big job. The success that this bureau has enjoyed is due in no small part to the cooperation that our tactful and efficient field forces have secured from the visiting public.

# THE NATIONAL PARK SERVICE IN YELLOWSTONE NATIONAL PARK

Superintendent Horace M. Albright.

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Yellowstone National Park is the first reservation of its kind to be established in the world. It is the forerunner of the great national park system of the United States. Foreign countries have copied the national park idea given to the world by the Yellowstone Park Dedication Act, and now there are national parks on nearly every continent. King Albert National Park in the mountains of the Belgian Congo established to protect its abundant wild life, particularly the gorilla, is one of the latest and biggest parks to be established in foreign lands, and the first in Africa. It is somewhat smaller than Yellowstone but its management is similar.

The Yellowstone, a great wilderness containing 3,348 square miles, lying astride of the continental divide in northwestern Wyoming, and overlapping into Montana and Idaho, is a magnificent bit of old America. A thin thread of roads make its most important features accessible; but to see it thoroly one must ride its thousands of trails, those paths thru the forests and over mountain passes not originally blazed with human hands, but first marked in the soil and rocks by countless thousands of elk, deer, mountain sheep, buffaloes, moose and bears.

More than eighty percent of the area is heavily forested. Its many lakes and streams send their waters to both oceans. The Indians

called it the "Land of Many Waters." The chief duty of the administration of the park is to protect its wild life, forests, and marvelous exhibitions of Nature's special handiwork. This is done with 31 permanent rangers, 4 buffalo keepers, and 52 temporary rangers employed only during the summer when the public visits the region. Seven great camping grounds for the public have been highly developed with water and sewer systems, comfort stations, garbage disposal facilities, tables, wood and other conveniences. These are used by upwards of 100,000 campers each year, many of whom spend their entire vacations in the park.

Visitors who come by railroads to the various entrances, are cared for in the hotels and lodges, and they tour the park via the very efficient bus line. Picture and curio shops, stores and other enterprises are operated for the benefit of all travelers. All of these public utilities are operated nuder franchises from the Government, and are closely supervised in the public interest. There is scarcely a vacation need that cannot be met in the wilds of the Yellowstone.

The National Park Service also has the task of maintaining in Yellowstone National Park, 356 miles of roads, nearly a thousand miles of trails, 360 miles of telephone circuits, several hay ranches on which hay is raised for winter feeding of the buffaloes and other animals; properties which, with the exception of the road system,

have been recently developed or rebuilt. Even the road system is undergoing extensive reconstruction. Nature study, ranger naturalist service and museum development, to make the tour of the park more enjoyable and beneficial, is meeting with great success. Interpretation of the park's wonders, and the story of Nature's building of the park region are proving to be most interesting alike to young and old.

All the service to the public in Yellowstone National Park is based on the fact that the park belongs to the people, and that when they come here they are entitled to friendly, courteous and kindly assistance. The park management eagerly awaits the opportunity to entertain the vast throngs of happy vacationists who will come this year. There should be no resisting the call of the Yellowstone.

THE RESPONSIBILITY OF FEDERAL & STATE GOVERNMENTS FOR RECREATION

(EXTRACTS)

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Dr. John L. Merriam. Remarks at the National Conference of Out-Door Recreation, Washington, D. C., January 20, 1926.

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There are probably few aspects of normal life more distinctly personal than recreation.

Recreation as understood in this discussion is not easy to define. It is best probably to consider it as representing outdoor recreation for the purpose of rest, and of both spiritual and physical exercise of the type that builds up and strengthens.

Responsibilities of the Government (Federal) for contributing to meet needs of the people for outdoor recreation are assumed at present mainly thru two agencies; National Parks and National Forests.

National Parks have been established thus far almost entirely from public domain for the purpose of protecting and administering for ~~for~~ use of the people, areas containing exceptional natural features with sufficient surrounding territory to preserve their primitive characters unimpaired. The purpose of use and enjoyment in the highest recreational sense has been prominent in definition of their functions. The element of magnitude such as would permit undisturbed appreciation of these wonders has also been recognized in fixing wide boundaries.

Extracts Dr. J. L. Merriam

The recreational uses of national forests and national park reservations will unavoidably overlap in some respects. In the case of the forests the areas will be kept protected first because of economic value. In the case of the parks, general recreational, educational, and aesthetic uses have furnished the reasons for existence.

The National Parks are commonly considered as essentially designed for recreation and this must of course be one of their major functions. But the recreation for which they serve is secured under conditions particularly favorable to education and growth of mind and spirit as well as body.

Under the guidance of recent administrations National Parks have developed steadily in the direction of educational influence thru use of the unsurpassed illustrations of natural phenomena, which were the features that brought about their creation as separate establishments under the Government.

There are not in America other places where there may be found so great an opportunity for effective adult education concerning nature with the grandest products of creation themselves as teachers. There is nowhere a larger opportunity to teach clear thinking, and to prepare a multitude of minds for honest reasoning. It is like a super-university, where the professors would be only guides and not instruc-

tors. And why should we not have for this great possibility of educational work an endowment adequate to prepare the way for most effective use by all to whom the opportunity comes, and a faculty chosen from the leaders in thought and appreciation; a group of men who, standing in the vivid presence of the Creator, would speak only the simple truth?

While the National Parks serve in an important sense as recreation areas, their primary uses extend far into that fundamental education which is true appreciation of nature. Beauty in its truest sense receives expression and exerts its influence along with recreation and education. To me the Parks are not merely places to rest and exercise and learn. They are regions where one looks thru the veil to meet the realities of nature and the unfathonable powers behind it.

OFFICIAL REPORT OF THE NUMBER OF ANIMALS YELLOWSTONE NATIONAL PARK

Copy of a letter to

DIRECTOR OF THE MUSEUM J.T.HAYNES from CHIEF RANGER S.T.WOODRING

April 5th, 1926

---

Replying to your inquiry of March 30th will advise that our latest figures on the wild animals based on the counts and observations of the past year are as follows:

| | | | |
|---|---|---|---|
| Buffalo, Lamar River Herd | | Full count | 740 |
| Buffalo, Cold Creek- Pelican Flats Herd | | Estimated | 125 |
| | Actual counts this season 62 | | |
| | | Total | 865 |
| Mountain Sheep | | Estimated | 600 |
| Antelope | Actual counts 497 | Estimated | 510 |
| Moose | | Estimated | 525 |
| Deer, Mule Tail | | Estimated | 1725 |
| Deer, White Tail | | Estimated | 10 |
| Elk | | Estimated | 15500 |
| Black Bear | | Estimated | 700 |
| Grizzly Bear | | Estimated | 75 |

These figures vary somewhat from the counts submitted in the 1925 annual report, particularly with reference to the antelope, deer, elk and buffalo; the antelope figure is based on actual counts submitted in December. The other variances result from taking into account the losses that have occurred during the fall and winter months; these losses include kills by hunters outside the park, winter kills, predatory animal kills, and death resulting from accidental injuries. All shipments have likewise been deducted from the herd totals.

Trusting I have answered your inquiries fully, I am

Sincerely yours,

(signed) Sam T. Woodring.

PRECISE ELEVATIONS ** YELLOWSTONE NATIONAL PARK

Determined by U. S. Coast and Geodetic Survey in 1923.

| Place of Marker(Concrete Post unless otherwise specified) | Elev. in ft. |
|---|---|
| NORTHERN ENTRANCE--Concrete post at Ranger Station | 5313 |
| MONTANA-WYOMING STATE LINE-- 50 ft. east of highway | 5631 |
| POST OFFICE--MAMMOTH HOT SPRINGS-- | 6238 |
| MAMMOTH-GOLDEN GATE ROAD-- 2½ miles from Mammoth | 7017 |
| GOLDEN GATE--3ft. above road 100 ft. south of Rustic Fall | 7255 |
| SEVEN-MILE BRIDGE-- 75 ft. north of Gardiner River, and 10 ft. from road | 7289 |
| APOLLINARIS SPRING-- 15 ft, from road 100 ft. n.w. of spring | 7336 |
| OBSIDIAN CLIFF--on east side of road in top of boulder | 7382 |
| OBSIDIAN CREEK-- 150 ft. east of sign | 7450 |
| ROARING MOUNTAIN-- 20 ft. east of road | 7574 |
| FRYING PAN SPRING-- 150 ft. south of spring | 7519 |
| NORRIS JUNCTION-- | 7483 |
| NORRIS GEYSER BASIN-- at south end of boardwalk | 7550 |
| GIBBON RIVER RAPIDS-- 2¾ miles south of Norris Jctn(boulder) | 7433 |
| GIBBON MEADOWS--opposite cliff 4½ miles south of NJ " | 7334 |
| BERYL SPRING | 7311 |
| GIBBON RIVER BRIDGE--6-2/3 miles from MJ(retaining wall) | 7184 |
| GIBBON FALL-- 2 ft. from stone wall at summit of hill | 7133 |
| GIBBON RIVER BRIDGE-- 3½ miles east of MJ (steel bridge) | 6926 |
| ROAD-- 1-2/3 miles east of MJ. Boulder 20 ft. south | 6862 |
| MADISON JUNCTION-- at northeast corner of triangular plot | 6804 |
| WESTERN ENTRANCE-- 1-6/10 miles east of WE in boulder | 6688 |
| ROAD-- 3-7/8 miles east of WE- in rock 15 ft. from center | 6705 |
| ROAD-- 5¾ miles east of WE- in top of boulder | 6734 |
| ROAD-- 6¼ miles from MJ- in top of boulder | 6752 |
| ROAD-- 4 miles from MJ- in top of flat rock 12 ft. from | 6760 |
| ROAD-- 2 miles west MJ- in top of flat boulder | 6788 |
| MADISON-OLD FAITHFUL ROAD-- 2-1/10 mi. so. of MJ in a rock | 7102 |
| ROAD-- 4 miles from MJ | 7153 |
| NEZ PERCE CREEK BRIDGE-- | 7175 |
| MAMMOTH PAINT POTS-- 60 ft. west of | 7316 |
| BRIDGE--(Firehole River)- 4¾ miles from Old Faithful | 7236 |
| ROAD-- 2 miles from Old Faithful | 7337 |
| OLD FAITHFUL GEYSER-- | 7365 |
| KEPLER CASCADE-- | 7582 |
| SPRING CREEK CANYON-- 4 miles from OF- in boulder | 7672 |
| ROAD-- 6 miles from OF in boulder | 7919 |
| ROAD-- 7 miles from OF in boulder | 7978 |
| CONTINENTAL DIVIDE-- 8½ miles from OF | 8261 |
| HERON CREEK BRIDGE-- | 7997 |
| ROAD-- 7¼ miles from West Thumb- in boulder | 8089 |
| ROAD-- 4¾ miles west of WT ranger station- in boulder | 8320 |
| CONTINENTAL DIVIDE-- second crossing | 8364 |

| Location | Elevation (ft.) |
|---|---|
| ROAD-- 2½ miles west of WT- in large rock | 8227 |
| WEST THUMB JUNCTION-- 150 ft. n.e. of ranger station | 7782 |
| SOUTHERN ENTRANCE-- ¼mi. no. of- top of rock 60 yds. east | 6882 |
| ROAD-- 2 miles from SE- in large stone | 7152 |
| ROAD-- 4¼ miles from SE- in rock | 7565 |
| ROAD-- 5-7/8 miles from SE- in top of boulder | 7858 |
| ROAD-- 7-7/8 miles from SE- in large boulder | 7763 |
| ROAD-- 10 miles from SE- in gray boulder | 7741 |
| ROAD-- 11½ miles from SE- in boulder, 40 ft. south | 7805 |
| LEWIS LAKE-- 7-3/8 miles south of WT- rock west of road | 7786 |
| ROAD-- 7½ miles south of WT- in rock | 7802 |
| ROAD-- 4-7/8 miles south of WT- in top of rock | 7896 |
| ROAD-- 3-3/8 miles south of WT- in rock 150 ft. south of rd. | 7968 |
| ROAD-- 2½ miles south of WT- in rock 50 ft. west of road | 7918 |
| CONCRETE CULVERT-- 50 yds. west of 2nd mile post north of WT | 7736 |
| CULVERT-- 4½ miles from WT | 7737 |
| ROAD-- 5-7/8 miles from WT- boulder 16 ft. west of road | 7860 |
| ROAD-- 8¼ miles from WT- in rock | 8428 |
| ROAD-- 6-7/8 miles s.w. of LJ- in top of rock | 8041 |
| ROAD-- 5-1/10 miles s.w. of LJ- horizontal rock ledge | 7842 |
| YELLOWSTONE LAKE-- 4 ft. above water level- 6 ft. below rd. | 7734 |
| CONCRETE CULVERT-- 2-1/8 miles s.w. of LJ | 7745 |
| LAKE HOTEL-- 35 ft. above the Lake- 45 ft. south of road | 7761 |
| LAKE CAMP-- 150 ft. east of Camp- 1¼ miles south of LJ | 7760 |
| LAKE JUNCTION-- In triangular plot | 7791 |
| EASTERN ENTRANCE-- 60 ft north of ranger station 300 ft west of entrance | 6950 |
| ROAD-- 1½ miles from entrance- disc vertical in boulder | 7083 |
| ROAD-- 4⅞ miles from entrance- disc vertical 40 ft east | 7485 |
| ROAD-- 5½ miles from entrance- in large boulder | 7778 |
| WALL OF TUNNEL-- in s.e. wing-wall- 6-2/3 miles from EE | 8161 |
| SYLVAN PASS (as determined by National Park Service) (by civil engineer W.I.Davis) | 8559 |
| SYLVAN LAKE-- 30 ft. from lake, 60 ft.so.- 4 ft. higher than | 8413 |
| ROAD-- 11 miles from EE- in large boulder | 8498 |
| ROAD-- 12-15/16 miles from EE- 57 yds. no. of rd.- boulder | 8471 |
| ROAD-- 15½ miles from EE in boulder | 8445 |
| ROAD-- 10 miles from LJ- in boulder | 8123 |
| ROAD-- 7¾ miles from LJ- in boulder | 7956 |
| ROAD-- 6 miles from LJ | 7995 |
| ROAD-- 3-2/3 miles from LJ- 20 yds from Squaw Lake | 7792 |
| ROAD-- 2 miles from LJ- 180 ft. east of Pelican Creek | 7739 |
| ROAD-- 2 miles north of LJ- in top of stone | 7759 |
| ROAD-- 3-3/8 miles north of LJ- in top of stone 200 ft. west of water station | 7717 |
| MUD VOLCANO-- 6¼ miles from LJ- 15 ft. from edge of road | 7749 |
| ROAD-- 7 miles s.e. of Canyon Junction- concrete bridge | 7686 |
| ROAD-- 6½ miles s.e. of CJ- in n.w. corner of concrete bridge over Trout Creek | 7684 |
| ROAD-- 5 miles s.e. of CJ- 45 ft. west of road center | 7737 |
| ROAD-- 2¾ miles south of CJ- top of large boulder | 7636 |
| CANYON JUNCTION-- 30 ft. so. of rd. center at top of cut | 7733 |

| Location. | Elevation (ft.) |
|---|---|
| CANYON-NORRIS ROAD-- 2 miles west of CJ- small rock | 8121 |
| GRAND CANYON-- 10 ft. from Canyon at junction of Ins.Pt.Rd. | 7799 |
| ROAD-- 2½ miles north of CJ- boulder west of road | 8014 |
| ROAD-- 4-9/10 miles north of CJ- rock ledge west of road | 8549 |
| DUNRAVEN PASS-- jctn of road to summit of Mt. Washburn | 8859 |
| ROAD-- 9-1/8 miles from CJ- set in vertical wall of rock | 8855 |
| MT. WASHBURN-- ( as determined by National Park Service civil engineer W.I.Davis ) | 10317 |
| ROAD JUNCTION-- where Washburn road re-enters- 9 miles south of Tower Junction | 8751 |
| ROAD-- 7¼ miles south of TJ- boulder 6ft. above road | 8017 |
| ROAD-- 5-1/8 miles south of TJ- boulder 15 ft. west of rd. | 7326 |
| TOWER FALL PUBLIC AUTO CAMP-- 15 ft. south of road and 200 ft. south of Haynes Shop- where Tower Fall trail enters- in top of boulder | 6597 |
| ROAD-- 2-1/10 miles s.e. of TJ- in cliff at west of | 6509 |
| TOWER JUNCTION-- 20 ft. east of road intersection | 6264 |
| ROAD-- 2½ miles west of TJ- rock at south edge of cut | 7000 |
| ROAD-- ¼ miles north of Crescent Hill- rock west of road | 7571 |
| ROAD-- 6½ miles n.w. of TJ- large rock north of road | 7190 |
| ROAD-- 8½ miles east of MJ- flat boulder 35 ft. so. of rd. | 6791 |
| ROAD-- 5-7/8 miles east of MJ- granite boulder south of | 6630 |
| ROAD-- 4-1/3 miles east of MJ- top of stone parapet support | 6669 |
| GARDINER RIVER STEEL TRESTLE-- 1-6/10 miles east of MS- in west abutment | 5961 |
| POST OFFICE--MAMMOTH HOT SPRINGS-- | 6238 |

TABLE OF SURFACE TEMPERATURES OF HOT SPRINGS AND FUMAROLES

EXTRACTS

**

Dr. Arthur L. Day 1925 Dr. E. T. Allen

Geophysical Laboratory, Carnegie Institution of Washington, D. C.

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NOTE: Temperatures taken at the surface,- Centigrade thermometers.

| | Temp. C. | Temp. F. |
|---|---|---|
| BOILING RIVER Below Mammoth | 48.5 | 119.3 |
| MAMMOTH HOT SPRINGS | | |
| Canary Terrace | 65.2 | 149.36 |
| Jupiter south end (strongly boiling pools) | 69.0 | 156.2 |
| " " " " | 71.7 | 159.98 |
| " " " " | 67.0 | 152.6 |
| Mound Terrace (in most active springs) | 66.3 | 150.34 |
| Cleopatra Terrace top south end | 71.0 | 159.8 |
| Angel Terrace | 65.0 | 149.0 |
| Highland Terrace | 71.5 | 160.7 |
| White Elephant north end | 59.2 | 138.6 |
| Stygian Cave top | 41.8 | 107.24 |
| Cheops (so marked) | 53.0 | 127.4 |
| Orange Spring | 60.0 | 140.0 |
| Bath Lake | 47.0 | 116.6 |
| ROARING MOUNTAIN | | |
| Spring in gulch north of center | 92.7 | 198.86 |
| Vent on slope near north end | 92.5 | 198.5 |
| NORRIS BASIN | | |
| Foot of terrace near old lunch room steam | 103.6 | 218.48 |
| Hurricane Pool | 90.0 | 194.0 |
| Black Growler | 140.0 | 284.0 |
| Verma Spring | 94.0 | 201.2 |
| Valentine Geyser (toward end of eruption) | 93.0 | 199.4 |
| CHOCOLATE POTS BELOW NORRIS | | |
| Pot near river side | 54.0 | 129.2 |
| " nearer the road | 55.4 | 131.72 |
| BERYL SPRING | | |
| Spring proper | 92.0 | 197.6 |
| Steam vent close by | 97.0 | 206.6 |

Surface temperatures 1925

| | Temp. C. | Temp. F. |
|---|---|---|
| **LOWER BASIN** | | |
| Mammoth Paint Pots | 93.5 | 200.3 |
| The Jet | 94.0 | 201.2 |
| Clepsydra | 92.0 | 197.6 |
| Indigo Pool | 95.4 | 203.72 |
| **NORTH SIDE OF RIVER FIREHOLE BASIN** | | |
| Firehole Lake | 80.5 | 176.9 |
| Hot spring emerging from sinter sheet above Black Warrior | 94.3 | 201.38 |
| Great Fountain | 96.0 | 204.8 |
| **BISCUIT BASIN** | | |
| Sapphire Pool | 93.0 | 199.4 |
| Jewel Geyser (just before eruption) | 95.0 | 203.0 |
| Jewel Geyser (just after eruption) | 92.0 | 197.6 |
| **UPPER BASIN** | | |
| Morning Glory | 77.0 | 170.6 |
| Fan | 93.0 | 199.4 |
| Mortar | 94.2 | 201.56 |
| Chinaman | 93.5 | 200.3 |
| Topaz | 94.8 | 202.64 |
| Teakettle | 94.0 | 201.2 |
| Lion | 93.8 | 200.64 |
| Ear | 94.2 | 201.56 |
| Beach Spring | 89.3 | 192.74 |
| Giantess | 94.2 | 201.56 |
| Lioness | 94.8 | 202.64 |
| Sponge | 95.0 | 203.0 |
| **BLACK SAND BASIN** | | |
| Handkerchief Pool | 83.5 | 182.30 |
| Emerald Pool | 69.3 | 156.74 |
| Cliff Spring | 91.1 | 195.98 |
| Black Sand Pool | 93.0 | 199.4 |
| Punch Bowl | 94.5 | 202.1 |
| Comet | 94.8 | 202.64 |
| Splendid | 93.6 | 200.48 |
| Daisy (just before eruption) | 94.0 | 200.1 |
| Daisy (just after eruption) | 91.0 | 195.8 |
| **HEART LAKE** | | |
| Rustic Geyser (pool) | 84.0 | 183.2 |
| Small geyser 45 ft. NE of Rustic - in hole | 94.0 | 201.2 |
| Largest pool in area | 88.6 | 190.4 |

Surface temperatures 1925

| SHOSHONE GEYSER BASIN | Temp. C. | Temp. F. |
|---|---|---|
| Union Geyser, three cones, all boiling: | | |
| " " Eastern cone | 93.0 | 199.4 |
| " " Central cone | 93.5 | 200.3 |
| " " Western cone | 93.0 | 199.4 |
| Minute Geyser | 92.5 | 198,5 |
| Union geyser area: | | |
| Clear blue circular pool, 68 yds NE of U.G. | 94.8 | 202.64 |
| **STEAMBOAT POINT YELLOWSTONE LAKE** | | |
| Area 100 yds to south: | | |
| Roaring vent escaping from rock | 103.0 | 217.4 |
| **YELLOWSTONE RIVER ROAD** | | |
| Mud Volcano | 84.0 | 183.2 |
| Dragon's Mouth | 75.0 | 167.0 |
| **CALCITE SPRINGS** | | |
| Steam vent 25 ft down the river | 94.0 | 201.2 |
| Boiling springs near river's edge | 94.3 | 201.74 |
| Spring higher up on slope | 72.0 | 197.6 |
| **NYMPH SPRINGS** | 51.1 | 123.98 |

TABLE OF BOILING POINTS OF PURE WATER ETC...

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Table of Boiling Points of Pure Water at Elevations of 6,000 to 8,000 feet above mean sea level. At mean sea level the boiling points are 212 degrees Fahrenheit (F.) or 100 degrees Centigrade (C.)
and
Notes on effects of dissolved salts and gas on boiling points; and superheated water and steam; and the source of the heat in the Yellowstone National Park Thermal Waters.

From data supplied the Yellowstone Park Museum, February 17 - 1926 by Drs. A. L. Day and E. T. Allen of the Geophysical Laboratory, Carnegie Institution of Washington, D. C.

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At elevations between 6,000 and 8,000 feet the average readings of the barometer lie between about 23.5 inches and 21.5 inches or in round numbers 600 millimeters and 545 millimeters. The following short table gives the boiling points of pure water for pressures within this range:

| Approx. Elevation feet | Average Bar. Pressure inches | mms. | Temperature Fahren. | Cent. |
|---|---|---|---|---|
| 8,000 | 21.52 | 546.3 | 195.8 | 91.0 |
| 7,600 | 21.92 | 556.7 | 196.6 | 91.5 |
| 7,200 | 22.34 | 567.2 | 197.6 | 92.0 |
| 6,800 | 22.76 | 577.9 | 198.4 | 92.5 |
| 6,400 | 23.18 | 588.8 | 199.4 | 93.0 |
| 6,000 | 23.62 | 599.9 | 200.3 | 93.5 |

The boiling points of several springs are slightly raised by the presence of dissolved salts and are lowered by the presence of gas. The sum of the two corrections is usually negative and sometimes amounts to several degrees Fahrenheit. On the other hand, certain alkaline waters in the park are subject to a phenomenon known as superheating which means that steam and water are not in equilibrium as they are in true boiling and as they would be if the waters could be very vigorously stirred thruout. The ultimate cause of

this deserves further investigation but the fact that there is little gas in such springs, the escape of which would stir up the water, is probably the immediate cause of the superheating.

Natural steam vents or fumaroles give out steam which is sometimes saturated and sometimes superheated. Superheated steam, it will be remembered, has a lower pressure than saturated steam at the same temperature and cannot be in equilibrium with water, as the steam in a boiler is. Steam rising from an aqueous solution of any kind is superheated. The magma or molten liquid from which rocks crystallize is charged with steam and other gas~~ses~~es and is a complex solution. Steam rising from such a fluid would necessarily be superheated, and it is our theory that the hot springs of the Yellowstone National Park are surface waters heated by steam of such origin.

# THE GEYSERS OF YELLOWSTONE NATIONAL PARK-

A lecture by Dr. Frank Thone as delivered at Mammoth Hot Springs, season of 1922.

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Opening paragraph omitted; must be varied according to season and other circumstances.

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Come back with me for a moment to a time when the earth was young. There was in those days no Yellowstone National Park- no North American continent even. Far to the east where the Appalachian Mountains now are rose a high mountainous island mass. To the west there rose a similar mountainous island mass and in between the two lay a vast shallow inland sea. The animals that lived in that sea left their shells and skeletons on the bottom when they died and these in the course of the ages accumulated and hardened into vast beds of limestone. The rivers that flowed through the mountainous islands carried down with them great quantities of sand and silt which in the course of the ages accumulated and hardened into beds of sandstone, shale and slate. How long this process was continued we do not know, but it must have occupied a very long period of time for the total accumulations have reached a vast thickness. In the end, however, the sea bottom slowly raised itself above the surface of the water and became permanently land.

In the meantime the mountains to the west had become much worn down, and in the east new mountain ranges rose to take the place of the old, forming what is now known as the Rocky Mountain Region. The main ridges of the new mountain system, as we all know, run in a

north and south direction, but in places short cross ridges were also folded up, forming great mountain bowls. The area now known as Yellowstone Park occupies a part of what was once such a mountain bowl.

Now where we have intense mountain folding such as I have described, we are likely to have developed what geologists call lines of weakness in the surface of the earth - thin places where volcanic forces may become active. Volcanic activities on a vast scale took place in this mountain bowl. Within the bowl there were at least three enormous volcanoes, probably larger than any that now exist, and around its edges were a large number of smaller volcanic vents and craters. Naturally the quantity of lava produced was prodigious. There were many volcanic eruptions and flows, which slowly filled up the bowl and it even overflowed thru the low places in its rim, helping in the formation of the vast lava plains outside, notably to the west and south.

In time, however, the main phase of volcanic activities came to an end and the lavas flowed no more. There followed a second and lesser phase of volcanic activity in the shape of great floods of hot mud that flowed down the sides of the volcanoes overwhelming all of the forests that they found in their paths. The tops of the dead trees projecting above the cooling and hardening mud naturally rotted off, but the stumps, partly protected beneath the surface, decayed very slowly indeed. They fell to pieces atom by atom, and as they did so the wood was replaced atom by atom with silica, a

hard strong substance in solution in the water. So accurately did this silica replace even the most minute detail of the wood that we can now tell accurately what species of trees constitute the great petrified forests found in this place.

Curiously enough they are not such trees as are now found in this part of the world, but belong to genera represented in much warmer climates than this. There were such trees here as we now find in California and the Gulf States: the big redwoods, sweet gum, live-oaks, magnolias and many others. There were many of these hot mud flows and many forests were thus overwhelmed and petrified. At Specimen Ridge in the northeast part of the park there are at least 18 layers of petrified tree stumps, the roots of each layer above the tops of the preceding ones, thus indicating a succession of at least 18 of these mud flows.

In time the mud flows also ceased and the volcanoes at last were completely extinct. There followed, however, a third and final phase of volcanic activity - the development of geysers and hot springs. A geyser is not a primary volcanic phenomenon, that is, its waters do not come from deep within the bowels of the earth as did the lava and hot mud. They are instead simply surface waters that have trickled down from fissures and cracks in the earth and have been heated by volcanic steam rising from still uncooled masses of lava far below. For the formation of a geyser, or hot spring, three things are necessary. First, a supply of heat. This comes, as I have already indicated, from steam that forces its way thru the earth from the masses of buried lava that have been so thickly

blanketed that they have not yet had time to cool, the mass may have elapsed since they were first forced into their present position. The second condition is a tube or vent, thru which the eruption can take place. This may be simply a crack in the earth or it may be a tube that the geyser has formed for itself out of silica. The third condition is, of course, a supply of water. This comes always from the surface from melted snow or rain. The water trickles into the tube either thru the top or thru underground channels opening into the sides of the tube, fills it up, becomes heated and super-heated by the steam rising from the hot lavas below and finally blows up in a violent eruption.

It may be worth while to note in passing the reason why geysers have not been developed here at Mammoth as they have been at the other places in the park. The formation here at Mammoth consists ~~xxxxxx~~ entirely of limestone - soft, chalky, and very weak. Accumulations of energy sufficient to cause geyser eruptions would very quickly rip the formation here to pieces. The formation elsewhere in the park consists of silica which is much harder and stronger than limestone and is thus able to form tubes which can withstand the explosive pressure that accompanies geyser eruptions. Hence we have here at this place the constant slow bubbling whereas in the geyser basins we have the accumulations of energy and the final violent blow-off.

Now after the geysers and hot springs had been in action for some time there came over the earth that peculiar change of climate that brought about the glacial epoch, or great ice age. The ice

in this part of America was not connected with the great continental ice sheets that formed in the northeastern part of the United States and over most of northern Europe. They were instead huge mountain glaciers of ordinary type. These slowly pushed their way across the park plateau and down the valleys, gouging out great masses of rock which they ground down to boulders and crushed to powder. When the ice age came to an end and the glaciers melted and retreated, these loads of boulders and silt were dumped in the ice-cut valleys forming the rounded hills or moraines which we can see all about us here in the canyon of the Gardiner. We know that the glaciers came after the geysers and hot springs had been formed because at the top of Terrace Mountain, directly above us here, there is a deposit of glacial boulders on top of the hot springs limestone formation.

After the glaciers had disappeared the climate continued to grow milder and there was a return of the vegetation which had been banished during the glacial epoch. The trees that came in, however, were not the trees that had departed. They are a sterner, hardier race, fit to cope with the more severe climate that has been left us as a heritage of the ice age. The trees that form the bulk of the forests that cover the larger part of the park are lodgepole pines. The lodgepole pine is the dominant tree on the park plateau, the tall, slender, rather weedy tree that grows in such dense and crowded stands almost everywhere. Below the lodgepole pine level we have the limber pine, so called because its twigs can be tied into knots without breaking. This is the common pine in the neighborhood of Mammoth.

Above the lodgepole pine level is the whitebark or whitebark pine. This is a close relative of the limber pine, but grows only on the high mountain elevations. Considerable growths of this tree occupy the flanks of Mt. Washburn. In addition to the pine we have considerable quantities of Engelmann spruce, balsam fir, and Douglas spruce. These three species usually occupy the richer, moister valleys and ravines. In the drier woodlands of the park we have considerable quantities of that peculiar juniper which is usually called Red Cedar. Of the broad-leaved trees there are very few and those that we have are mostly two species of poplar: the little white barked quaking asp, or aspen, very common at lower elevations, and the narrow- leaved cottonwood, which is found in the valleys of the Gardiner and the Lamar rivers. Other genera that reach tree size at lower elevations, like maple, willow, birch, cherry, etc., are here nothing but tall shrubs. The open dry plains and hillsides of the park are occupied with a brush formation dominated by sage brush with a liberal admixture of rabbit brush and other drought-resisting bushes. There is also, of course, a great wealth of floral plants. Altogether about 600 species of flowering plants have been identified in the park.

Sheltered by the forests and supported, directly or indirectly, by the plant life is a great wealth of animal and bird life. The largest and most numerous of the larger mammals of the park is, of course, the elk. Recent estimates place the number of elk in Yellowstone Park at about 20,000. Much less numerous, the still present in considerable abundance, are the mule deer, and there are still a very few of the

white-tailed deer in the region. The park shelters a herd of about five hundred of the rapidly disappearing pronghorns or American antelopes and a considerable number of magnificent bighorns or Rocky Mountain sheep. On the borders of the park we occasionally get glimpses of the Yellowstone moose, a very peculiar animal quite distinct from the huge northern moose of Maine and Canadian woods. Of course the great pride of the park is the herd of American buffaloes, or bison, which started a little less than 30 years ago with about 25 animals and has increased its number under the careful protection and feeding they receive here until the herd now numbers more than 700 specimens. Beasts of prey are the only things that are ever shot at or otherwise killed in the park, particularly the grey wolves and the American lion or mountain lion. There are considerable numbers of coyotes in the park and their number is kept within bounds by shooting and trapping, but they have not been so greatly reduced in numbers as have the other two groups of predatory animals.

Most interesting of all of the larger animals in the park to the average visitor is the bear. We do not frequently get to see the grizzly, for he is of a very shy and retiring disposition in spite of his ferocious reputation and avoids contact with human beings wherever that is possible. We may occasionally get a glimpse of him at the bear feeding grounds when he comes out at dusk to get his share of the food scraps that are thrown away. Much more pleasant and much more easy of approach are the black bears, for the brown and cinnamon bears are simply color phases of the common American or black bear, just as we have blondes, brunettes, and red-heads among people. Bears should

always be treated kindly but with caution. The frequent practice of letting them eat out of your hand while a friend takes a photograph is absolutely dangerous and is a thing that no experienced ranger or other park official or employee ever undertakes. Bears as a rule are not vicious, but it is to be remembered that they are exceedingly stupid and just as strong as they are stupid, so that a mere gesture of impatience on their part may be a disabling or even a deadly blow if a human being happens to be in the way of it. We, therefore, very strongly urge that you toss your offering of food upon the ground at a safe distance, say 12 feet at least, which will place the bear in a good photographing position and at the same time insure your own safety.

In addition to the furred animals of the park there are a great number of birds. The park, indeed, is one of the greatest natural bird sanctuaries in the world. All told, about 300 species of song birds and water-fowl visit us in the summer and some of them are here all of the year. The American or bald eagle is a permanent resident in the high mountains around the border of the park. We seldom see him near the roads except on the wing occasionally. A bird which is frequently taken for the eagle, and whose nest is sometimes pointed out as an eagle's nest, is the osprey or fish-hawk. The osprey is much less shy of human approach and builds his home freely on lofty pinnacles of rock or in the tops of tall dead trees. Smaller hawks are here in abundance and also a great number of owls. Along the stream courses one will frequently find great numbers of ducks and geese and wading birds, and at Yellowstone Lake are two of the most

interesting water bird colonies to be found in the United States. There are about 200 pelicans and an indeterminate number of gulls at this place. These birds come up every spring from the warm waters of southern California where they spend the winter. Of smaller birds there is a great wealth. Perhaps the bird most frequently noted is the western bluebird which is blue all over - a bird to delight the heart of Maeterlinck. Another interesting small bird, which stays here all year round, is the water-ousel. Altho a water bird the ousel does not have webbed feet like a duck nor long legs like a snipe. He is a literal submarine bird which can walk on the bottom of rushing streams, clinging with his strong toes to the stones at the bottom. He builds his nest as a rule under a rock in the middle of a rushing rapid or beneath a waterfall.

Author's note: These notes on the plant, animal and bird life of the park may be varied to suit the occasion and to fit the time at the lecturer's disposal. As originally given the treatment of the birds was placed before that of the animals so that the lecturer could wind up effectively with a discussion of the bears. At the close the audience was solicited for questions.

Typed finally April 9th, 1936.

THE GEOLOGICAL HISTORY OF YELLOWSTONE NATIONAL PARK

Season 1925 Ranger Gerrit Dewink

Revised to date and approved by: May 30, 1926.

Superintendent Horace M. Albright,
Dr. H. S. Conard, in charge of the ranger-naturalists,
Mr. J. M. Haynes, Acting Director, Yellowstone Park Museum.

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I suppose that many of you have been suspicious of my subject from the moment it was announced. The first mention of geology as something of interest here in the park might make some people run for shelter. One is curious, of course, about the things around here, and naturally seeks explanations; but perhaps, at one time or another having read a technical pamphlet or dipped into a book on geology; or having probably talked to some scientific man, has become too impressed by the complexity of the subject and perhaps discouraged as well. Well, I am not going to lecture on geology in a technical way at all. I am not going to bother you with complex scientific terms which have no particular meaning for the person who has not made special study of advanced geology. And along this line I like to relate an incident which took place in Yellowstone a number of years ago. Battling Nelson, the prizefighter, once spent a summer here training for one of his important fights. At the end of the summer he thought he might commercialize on his experience somewhat and get out a booklet entitled: 'MY EXPERIENCES IN YELLOWSTONE'. When this work was finished, he noticed that something was lacking. He felt that he should have a brief geological treatise to go along with his book. Now Battling Nelson's ideas on geology were elementary, to say the least, and so he arranged for an interview with Arnold Hague, an eminent geologist

who was studying Yellowstone at that time. Arnold Hague saw the chance for some fun at Battling Nelson's expense, and so he evaded most of the questions put to him by the fighter, pleading ignorance of them and showing a surprising lack of understanding of all that Nelson was talking about. And finally Battling Nelson became impatient and exclaimed, "Well now, Mr. Hague, to get down to something simple and definite, what, for example, is that mountain over there?" "Oh", said Arnold Hague, "Why that's an andesitic porphery with radical spherulitic inclusions." Battling Nelson later said that that was the nearest he ever came to being knocked out.

I am not comparing you to an audience of Battling Nelsons; but I shall endeavor to explain the more prominent features of the park in everyday language which I hope will be interesting to you. Necessarily, I must do this in a very sweeping, general way, - the idea of covering the geological history of the park in thirty minutes is inconceivable. But I can suggest broad outlines upon which you may base your observations as you travel thru Yellowstone.

I am going to follow the method of the geologist who goes "deep" into his science, and talk to you of an orderly succession of geological layers, which reveal the processes and stages thru which this part of the earth's crust has passed.

The first layer with which we are concerned is that of the sedimentary rocks, - the old sea bottom. At one time all of this district must have been covered with a shallow sea. We know this because fossils of fishes

and other sea animals have been found in this layer. The limestone stratum also shows that it is of sedimentary origin. Mud and silt carried down by rivers, together with the vegetable and animal deposits, formed a layer of considerable thickness on the sea bottom. Later, as the waters receded, this sedimentary layer was revealed as land in the ordinary sense of the word. There is a large deposit of sedimentary rock in Mt. Everts, which may be seen from the hotel. These sedimentary deposits are of real interest when we come to consider the hot springs, and I want you to keep them in mind. It suffices to say here that they constitute one of the lower layers upon which other geological layers have been built.

On top of the sedimentary rocks we find the igneous rocks, - the lava flows. Most of the present topography of the park has been mounded by volcanic action. You will see evidences of it everywhere as you go along. The central portion of the park is a broad plateau, formed by lava flows, filling up what was formerly a great valley. Many of our mountains here are great banks of lava which have piled up above the general level, and it is most interesting to observe the crystalline forms of the rocks exposed by erosion, as well as the variety of their composition.

As you pass thru Golden Gate there is an opportunity for close-up observation of this igneous rock structure. Obsidian Cliff is essentially a mountain of volcanic glass, - a substance formed by lava which cooled so quickly that it did not crystallize. Again, just beyond Tower Fall, you will be curious about a long layer of upright, pentagonal columns. Most people are surprised at the eveness and regularity of these rock

columns. Under favorable conditions, lava masses in cooling tend to assume certain geometric forms related to the principal constituents of the lava. These five-sided columns are remarkably symetrical. And so, in going around the park, one observes immeasurable masses of igneous rock.

After the igneous rocks we have the glacial deposits. I said that most of the present topography of the park was due to lava flows. In many places it has been modified by glacial action. Here and there the glaciers wore down the knobs and higher places, and gouged out the valleys more deeply. Then, too, there are the glacial deposits, - great banks and mounds of gravel piled up by the ice sheet, and also huge boulders which were left along the path of the glacier. Capitol Hill, directly in front of the hotel, is a good example of a glacial terminal moraine. The gravel hills between Mammoth and Gardiner have been deposited by glaciers. At Canyon you will see the glacial boulder, a huge rock which rests on an andesitic lave flow. The only plausible explanation is that it was carried by a glacier, and it must have been transported several miles, because the nearest source of granite, of which it is composed, is some twenty miles off, - rather interesting evidence of glacial activity.

Finally we come to the thermal deposits, and that, after all, is what you are probably most interested in. I mean the hot springs and geysers. Yellowstone has the greatest hot springs and geysers in the world, and I want to explain just a few things about them. I shall take up the hot springs first.

The white substance which you see deposited on the hot spring formations is called travertine. It is composed largely of calcium carbonate, with some magnesium carbonate and some slight traces of sulphur, potassium, and other elements. The travertine is brought to the surface by a process which I shall explain by analogy. You know that in certain sections of the country they mine salt by pumping superheated steam and water down to the salt beds, thus forming a saturated solution of salt. This solution is pumped to the surface, the water evaporated off, and the salt remains. Now that is just about what is happening here, except that there is a different salt involved, and of course all phases of the process here are natural. Surface water seeps down thru the cracks and fissures in the earth and finally encounters heated rock layers, far below, or steam issuing from still deeper beds of lava. There are several considerations relating to the source of heat in these rocks. One is that the heat is the original heat of the earth which increases toward its center. Another is that the heat comes from lava flows which were covered over by successive flows so quickly that they never cooled. We have not the time to discuss this problem, - it would involve a lecture in itself, - I mention the main points only regarding this heat supply. The water rises to the surface as in ordinary cold water springs, but being hot and containing some carbonic acid gas as well, it readily dissolves the limestone thru which it passes, - the old sedimentary rock layer which I have spoken of. Coming to the surface the hot water evaporates very quickly, leaving behind the limestone deposit known as travertine. Some precipitation of this travertine is also due to the cooling of the water and the action of microscopic plants called algae. There is always

much speculation among tourists as to what causes the coloring on the hot spring terraces. One might assume, at first, that the coloring is due to mineral deposits, but this cannot be, because the coloring disappears as soon as the spring becomes inactive, whereas mineral coloring would be permanent. The explanation is that the coloring here is not due to minerals at all, but is formed by different varieties of microscopically small, hot water plants, - the algae. The variety of color is due to the fact that different varieties of algae grow in different temperatures of water. The algae follow their temperatures very closely, and this accounts for the uniform coloring of all of the springs. The sulphur colored algae will be found in the hottest water, and then the colors shade off gradually into yellows and browns and brick-reds, as the water cools. The coloring is probably the most beautiful feature of the hot springs terraces. The springs are constantly shifting and changing their activity, and the algae disappears whenthe spring dries up. Many old, inactive terraces, bleached white or weathered to a gray, cover Terrace Mountain.

The geyser does not differ much from the hot spring except in the structure of the tube which holds the water. In the case of the hot spring, this tube is either large enough or straight enough to allow circulation of water in the tube itself, which keeps all of the water at a more or less even temperature and the spring bubbles over very peacefully at the surface. In the geyser, however, the tube is narrow or crooked, of such a shape as to retard these convection currents. The water in contact with the heated rock below is therefore confined there until it eventually becomes so hot that it flashes into steam. The expansion of this steam throws the water

out of the tube, - this is the spouting of the geyser which you see. The deposit around the geysers is also different from that of the hot springs. It is a hard, flinty substance, mostly hydrous silicon dioxide, and it is deposited very slowly, whereas the travertine of the hot springs deposits rapidly and is a soft substance, easily broken. The hot springs and geysers are active winter and summer.

The Grand Canyon of Yellowstone is, of course, the climax to the park's magnificent scenery. Tourists are so taken up with its falls and beautiful tints that its geological significance is often overlooked. The canyon is a great gorge which has been cut down thru the lava flow by the Yellowstone River. The lava was gradually decomposed by erosion, perhaps aided by the hot springs and steam vents there, and the constant wear and friction of the river cut out the gorge. The coloring in the canyon is due to minerals. The lava flows contain many minerals and each of these ores takes on its particular hue as it is decomposed while exposed to the elements. We sometimes forget how the forces in nature have worked steadily for centuries preparing wonders which appeal too often only to the eye and not to our understanding.

Which brings me to say that the only people who have a real appreciation of Yellowstone are those who go about understanding. I know that the word "study" has an unfortunate connotation for some people who are on vacation, - they do not like the idea of studying about anything while traveling. All however, are invited to go over to our Museum and browse around. The National Park Service has people there who are working hard to supply information and service and who are well informed and glad to

answer questions. Rangers on duty there will show you the bird and flower exhibits and explain the geological exhibits of specimens. The government sells pamphlets there at a nominal cost which pertain to many of the surprising things about your park. I cannot impress upon you too much the value of visiting our Museum and taking advantage of what the people there have prepared for you and all of the park visitors.

Just one thing more. We rangers are supposed to be, in a way, recorders of the public sentiment. We are the government men with whom you will come in closest contact as you go thru the park. And we are anxious to get your impressions of things here. What do you think of the service you are getting in the park, of the organization and the managment of the park? Why, you people probably do not realize how much the whole spirit of the administration of the park is that what the people want, within reasonable limits, is exactly what they ought to have. And the best judge as to how we are succeeding is the public itself. That is why we want your reactions to things. Do not hesitate to make suggestions to your rangers. Mr. Albright, the superintendent, has repeatedly said that he welcomes suggestions more than compliments, because they show best how the service may be improved to make things more enjoyable for you. From the very nature of our office we are anxious to please.

If any of you have such suggestions to offer or any other questions to ask I shall be glad to talk to you immediately after the lecture.

(Signed) Gerrit Dennink

THERMAL DEPOSITION IN YELLOWSTONE NATIONAL PARK

Mr. J. E. Haynes, Acting Director,
Yellowstone Park Museum.

Criticised and approved by: May 30, 1926.

Superintendent H. M. Albright,
Dr. A. L. Day, Geophysical Laboratory of the Carnegie Institution,
Dr. F. W. A. Thone, Science Service, Washington, D. C.
Dr. H. L. Conard, in charge of the ranger-naturalists,
Ranger Chas. Phillips, Yellowstone Park.

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Ranger Charles Phillips, stationed during the winter of 1925-26 at Old Faithful, is the author of an article published in the Yellowstone Nature Notes, Vol. 111, No.2, of February 26, 1926, wherein he observes that after comperatively low temperatures (20° below zero) there is an unusual mineral deposit in the runoffs that carry the water away from Old Faithful Geyser; also that if the dissolved silica can be frozen out it is possible that the rate of growth of the high mounds of many of the geysers is not as slow as had been originally calculated.

This article attracted the attention of Dr. Frank W. A. Thone now with Science Service in Washington, D. C., who was formerly Park Naturalist in Yellowstone National Park, who transmitted to us the following extracts on this subject, obtained from Dr. Arthur L. Day, Director of the Geophysical Laboratory of the Carnegie Institution of Washington. The extracts are from an unpublished manuscript by the late Dr. Arnold Hague of the United States Geological Survey, which was written in the early 90's.

"Thruout the autumn and spring these waters, on freezing at night, de-

posit a considerable amount of mineral matter which in the aggregate must add largely to the precipitated silica.

"Demijohns of geyser water which has stood for one or two years at moderate temperature without any apparent change, failed to precipitate silica. In experimenting upon these waters in the laboratory it was noticed that on reducing them nearly to freezing point no change took place, but on lowering the temperature there occurred an abundant separation of free silica. The waters frozen in this way were collected from Coral Spring, Morris Basin, and Taurus Geyser, Shoshone Basin."

It might be proper here to consider the various names by which the prevailing silicious deposits in the park are known. Chemically, silica is silicon dioxide, or silicic anhydride, ($SiO_2$), occurring in nature in crystalline form as quartz, and in amorphous form as opal. Geyserite is a hydrated form of silica, deposited in white or grayish masses, porous, filamentous or scaly, around most of the hot springs and geysers. It is known also as silicious sinter, which has this chemical formula $SiO_2\ nH_2O$ (the "n" is variable).

Notwithstanding the fact that Mr. Hague has used the work "silica" in the above unpublished manuscript written in the '90's, he was particular to say in 1914, when he last visited the park that the deposits of silicious sinter there which are practically all hydrous, are not usually spoken of as being silica, since this latter term is used when anhydrous silica such as quartz is referred to. It is therefore advisable in our references to the geyser formations in the Upper, Lower, Midway, Shoshone,

West Thumb Geyser Basins and elsewhere, to use the terms geyserite or silicious sinter.

In geyserite, silicious sinter, slight traces of oxides of iron and other impurities actually color the rock various shades of yellow and pink. The forms of geyserite vary with the methods of deposition. Where the flow is more or less continuous the deposit forms in translucent layers, resembling mother-of-pearl in appearance. Where the water splashes in drops the sinter is beaded. Where the water is ejected in a fine spray it takes the form of small spines. Many craters exhibit all three types of geyserite. When the nature of the flow changes, intermediate forms develop and often the surfaces are striking in both their variety and beauty.

At Mammoth Hot Springs the deposits of calcium carbonate are not known as lime or limestone, which terms do not apply specifically to calcium carbonate formed from hot water. Therefore the correct terms to use for the calcium carbonate deposits are travertine, calc-sinter or calcium carbonate. This white travertine, varying from soft and chalk-like to hard and semi-crystalline, is deposited from waters holding lime in solution. The coloring on these deposits is due to algae and to certain bacteria which are low forms of plant life.

Sulphur occurs in a free state on the terraces at Mammoth, chiefly around the springs on the highest level. Free sulphur is also found on the park plateau, notably at Crater Hills and Sulphur Mountain. In the geyser basins pyrite (disulphide of iron - $FeS_2$) often gives the sinter a pearly-

black lustre and it sometimes forms a scum over muddy pools, giving the surface a metallic sheen. At Vorma Spring in the Norris Basin it occurs with free sulphur in the form of floating globules which may have developed over bubbles of carbonic acid gas. Pyrite, in its characteristic crystalline form is popularly known as "fool's gold".

Arsenic, the small in quantity, occurs in association with geyserite thruout the park. It seems to be especially abundant in the Norris Basin where it is found in combination with sulphur. Two pools in this vicinity are named for these compounds of arsenic, realgar ($As_2S_2$) and orpiment ($AS_2S_3$). The gray-green deposits around a few vents in the Upper Geyser Basin may be scorodite (arsenate of iron) referred to by Hague. Tourists who shy at the idea of arsenic in the park waters may be reassured by the fact that arsenical springs are among the most valuable in the treatment of nervous diseases.

Factors contributing to or associated with the depositing of geyserite and travertine are: (1) cooling (2) evaporation (3) freezing of the water (4) removal of the carbon dioxide gas from the water by the algae and by its escape due to heat and release of pressure. Some of this gas is extracted by the low form of plant life - the algae - which require it in their existence and development.

Definitions and Rates of Deposition of Geyserite and Travertine.

Travertine; calc-sinter; calcium carbonate; $Ca\ CO_3$; varies from soft chalk-like to harder semi-crystalline masses (principally at Mammoth).

In certain runways from the hot springs at Mammoth it has been observed that

travertine deposits very rapidly: 1/16th of an inch in three or four days. In others it is much slower, while articles allowed to remain in the still water of the pools for several days show practically no deposit, - in general it is safe to say that the more rapid deposition occurs where local evaporation is most rapid.

Geyserite; siliceous sinter, hydrated silica; $SiO_2$ $nH_2O$; white or grayish masses as hard as glass around most of the hot springs and geysers, except at Mammoth.

Tests have also been made to ascertain the rate of deposition of geyserite. Comparison of the appearance of the Grotto Geyser formation Old Faithful Geyser crater, Castle Geyser cone, and several others, in photographs taken over forty years ago, with these features as they are today, discloses no apparent change. Articles placed in the waters for several weeks take on slight deposits, but it is estimated that only in the places where they form most rapidly is a rate of deposition of 1/16th of an inch a year reached, except, possibly in basins near frequently erupting geysers where geyserite is frozen out of the water between eruptions during the winter months; but this deposit is largely washed away. The average rate, however, is considerably less than 1/32nd of an inch a year.

# YELLOWSTONE PARK ALGAE

Compiled by Ranger Marguerite Lindsl

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Criticised by:-

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Visitors to the Yellowstone are nearly always impressed with the beautiful colorings on the hot spring terraces about Mammoth and around almost all of the geysers and springs elsewhere in the park. These colors are due, for the most part, to algae, about which this paper has been prepared.

Alga (plural, algae) from the Latin word alga meaning seaweed. A distinguishing feature of the Algae as a group is that they are nourished thru their whole surface by the medium in which they live. They are unlike the fungi, which they most closely resemble, in that they are made independent by chlorophyll which is an organic substance which gives them and all plants of higher orders their green color and which enables them to use the carbon dioxide of the medium in which they live.

Algae vary in size from the microscopic diatoms and other minute forms found in Yellowstone Park, to sea forms whose stems resemble tree trunks and whose fronds rival the leaves of the

palm in size. From the giant kelps of the oceans iodine and bromine may be obtained. Algae are used to some extent as a fertilizer and there are many edible forms also.

There are four large divisions of the Algae. They are the blue-greens, the reds, the browns, and the greens. Of these the blue-greens are the most primitive and are the ones with which we are concerned. They are found universally. In moist climates they furnish some of the richest tints of the landscape, growing as they do on rocks, trees and where ever they can gain a foothold. They are found both in salt water and fresh water plankton, a name applied to the floating or weakly swimming, living, organic material or scum found on nearly all bodies of water. The "red" of the Red Sea is due principally to algae floating in the waters thereof. All over the world we find the blue-green algae associated with thermal waters. As early as 1827 Agardh, a botanist, described the algous growths of thermal waters in Carlsbad, Bohemia. They have been identified and studied in Iceland, New Zealand, the Azores, the Himalayas, Luzon, several parts of the United States, and other places. In Pluton Creek, California, in hot, acid water, Brewer claims to have found algae growing at 200 degrees Fahrenheit, which is the highest temperature at which they have been recorded. (biblio. #5) However, Professor Setchell of the University of California tells us that " the old observations at Pluton Creek have never been verified.

I, myself, could not find plants were growing in temperatures much over 50 to 60 degrees Centigrade." (122 to 140 degrees Fahrenheit). (biblio. # 5).

No organisms, with the possible exception of a few of the bacteria, can withstand the temperature extremes withstood by the algae. In the antarctic they were found as the principal vegetation of pools and lakes where they had a four weeks' period of growth at the best, and the rest of the year they were frozen. At times, conditions were so that they were frozen for two or three years without being thawed out at all. Professor Setchell sites Kjellman in a statement regarding marine forms, wherein the latter says that they develop and fruit in water never rising above -1 degree Centigrade. (30.2 degrees Fahrenheit.)

The blue-green group of the algae is very primitive and the living representatives of today are the descendents, probably little changed, of a group of organisms which were left aside very early in the evolution of plant life. The ability of life to withstand such high temperatures shows possible existence of such forms in the early history of the earth, when it was covered with highly heated, mineralized waters.

In Yellowstone Park in 1923, Dr. R. B. Harvey of the University of Minnesota reports, growing in the water of Beryl Spring, a kind of alga at 89 degrees C. (192.2 Fah.), which is the highest

reported temperature at which algae have been found there. (biblio. # 10). Dr. Harvey was working on an experiment to show that the temperatures of the waters and their mineral content, actually made it possible for these simple forms to obtain their food without the aid of certain chemically complex agents known as enzymes, which are necessary in food digestion in all of the higher forms. These thermal algae do not have the enzyme diastase, which is used to digest starch,-- also they lack other important ones of the enzymes.

The part played by the corals and the mollusks and others of the animals, in the building of rocks, has long been known, but a much more recent discovery is the part played by plants. Perhaps the best known example of the latter is the case of diatoms. You have heard of diatomaceous earth which is used as a polishing material and as an absorbent in dynamite. This is a white, silicious material composed entirely of the "glassy" shells of minute algae which, under the microscope, look and fit together like tiny celluloid soap-boxes. These plants have the power of utilizing the minute quantity of silica found in all water, in building their shells. They are found, to some extent, in these warm waters, but more often in cold water and to some extent nearly everywhere. In the white bands you see on dead trees and stumps in hot spring areas and bogs thru the park, just above the water line you will find diatoms. Silica of such dilute solutions is not readily separable by chemical processes, therefore the diatoms must ex-

tract it by some vital process of their own. (biblio. # 7).

There are many kinds of blue-green algae in the thermal waters of the park and you will notice widely varied colors. In waters over 150 degrees Fahrenheit, a colorless, filamentous, bacterial growth is found. If the temperature of the water is lower a pale, green-yellow algous form appears, sparingly at first and growing more abundantly, and more deeply tinted, as the water becomes cooler, to reds, browns, and olive-browns, a soft, velvety covering. In rapid currents the algae are in long filaments. In quieter water they are united in a membrane-like sheet, or in jelly masses inflated by gas bubbles tangled in the tissues. Where deposition is very rapid the algae are encased in the deposit and only the growing ends of the filaments are exposed and free.

The green forms are not as common in the thermal waters as the red and orange forms of the blue-greens, which predominate. However, where the algae have been torn up we will find a layer of blue-green color underneath the yellows. The mushroom-shaped forms are conspicuous in many shallow pools throughout the park and especially in the Upper and Lower Geyser Basins.

The blue-green algae are most generally encased in a gelatinous material to a greater or lesser degree, and this is what gives the slimy feeling to them. This mucilaginous material, encasing the cells of the algae, is most important in protecting them from

destruction by drought, making them resistant to drying.

As to the part played by the algae in building up the terraces of both the lime deposits of travertine and the silicious deposits of the geysers, geyserite, it is considerable. In the case of the former, probably they are the greatest factor. In the travertine deposits calcium carbonate is deposited, due largely to the extraction by algae of carbon dioxide in the water. That algae do actually cause elimination of this carbonate from water containing it in solution, was shown first by Cohn('62), and Weed('88) has given a very able account of the assistance of blue-green forms in the deposition of travertine and geyserite in Yellowstone Park.

The algae of hot springs often grow in gelatinous masses in which a form of silica gradually appears, and ultimately all but the peripheral portion becomes firmly silicified. Weed found the thickness of travertine formed in three days to be from 1/25 to 1/5 mm. In some formations which are deposited rapidly, it is difficult to discover the algal filaments at all, as they are encased in the formation with only the vegetating ends protruding. However, their presence may be demonstrated readily by the use of dilute hydrochloric acid which will dissolve out the lime and leave only a mass of filaments of the algae.

There are two varieties of travertine in which the algae do not enter into the deposition. First, the smooth, glassy formations inside of caves, such as the Devil's Kitchen, in which there is a slow deposition caused by crystallization from the superheated

solution of carbonate of lime due to the relief of pressure as the water approaches the surface: the second variety is the "hot water ice", the flaky sheets of pure travertine found first on the surface of warm pools and later as scaly flakes on the bottom. These are formed by the diffusion of the carbon dioxide gas due to long exposure.

There is another phase of the blue-green and the green algae which will be found interesting to the average person. These are the lichens, which are formed by the association of certain algae and fungi, dual organisms. This association of two entirely different groups of the plant kingdom is known as symbiosis, and differs from parasitism, in which one of the plants derives the benefit at the expense of the other, in that symbiosis is where both plants profit, a sort of a mutually beneficial arrangement. A fungus is a plant that is dependent upon organic material for its food. It has no green coloring material, chlorophyll, and therefore it cannot manufacture its own food. The algae are independent in this respect; given sunlight they can manufacture their food thru the agent, chlorophyll, by a process known as photosynthesis (put together by light). In the lichen the fungus fastens itself to a rock or a tree where it could not obtain its own living. It thus becomes a home for the algae, being a means of support which holds the algae up in the sunlight. The fungus in the dual result, takes the food which the algae produce, and the fungus

keeps the upper hand in this partnership by not allowing the algae to multiply except within certain limits. (biblio. # 4) In the park we find a fine example of lichen growth in the Golden Gate where the gold coloring of the rocks is due to a covering of them. Lichens are often beautiful, as the beard moss of Hiawatha. "- bearded with moss, and with garments green." Their color range is broad and they are often brilliant reds, warm browns, pea greens and others of the more unusual colors in Nature.

It is interesting to know the method of propagation of such forms as the algae. Most of them form reproductive bodies known as spores which are carried by the wind and the water and are capable of remaining in a resting stage for many months or even years, withstanding much heat, cold or other adverse conditions. For a long time this fact was used as an argument by the men who believed in spontaneous generation, as nothing was then known of these microscopic spores. When a new hot spring starts to come thru the ground the algae will be found growing there within a very short time after it breaks out. It seems miraculous unless one knows how they really managed to get there.

In concluding this brief story of the algae, it will be noted that they are common in various types, thruout the park, being found in cold streams and lakes as well as in the thermal waters. In fact they are common the world over, from the often frozen waters

of the polar regions to the equatorial zone, and in both fresh and salt water. However, such examples of beautiful coloring as are seen in the thermal waters of the Yellowstone are comparatively rare in the world of the algae.

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REVIEW OF THE BIRD LIFE OF YELLOWSTONE NATIONAL PARK

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## INTRODUCTION

A remark which one frequently hears from tourists in the park is that birds seem to be scarce in the reservation. That impression of scarcity is rather falacious, tho it does have some foundation. Most of the tourists come from sections of the country which are very much more settled. They are unused to bird life conditions in places where wilderness surroundings so vastly predominate. In the settled parts of the country the birds have perforce grown accustomed to highways and to highway conditions of traffic; to cities and villages and everything which is associated with proximite to civilization. That accounts for the fact that in such parts of the country the bird life is more intimate, more familiar; so that the layman from a populous region acquired the impression that birds are inclined to be bold and confiding. The fact is, however, that birds generally are timid and retiring by nature; and that fact is well shown in such an area as Yellowstone Park where natural conditions prevail. If there are few birds seen on the regular loop tour itself, as compared with the number which should be expected in an equally diversified ride in the country near New York, Philadelphia or Chicago, it is largely because of wilder places being available all about the park. In other words, the birds prefer wild conditions and in

Yellowstone Park such conditions are to be had in abundance; the birds do not have to dwellwithin the din and dust of traffic.

ONE EFFECT OF ALTITUDE

There is another condition which affects our bird life in a more fundamental way. The elevation of the park, -- approximately 5000 to 10,000 feet, -- does not favor maximum bird life, particularly as to number of species. Lower altitudes, other conditions being equal, are richer in number of species.

THE CHIEF FEATURE OF YELLOWSTONE BIRD LIFE

The bird life of Yellowstone Park is, therefore, not remarkable for number of species or abundance of individuals in general. The most outstanding feature of its bird life as a whole is perhaps the fine representation it contains of species which are typical of the Rocky Mountain region and characteristic of the Hudsonian and the Arctic-Alpine life zones.

NUMBER OF SPECIES AND THEIR AVAILABILITY

The list of known Yellowstone Park birds has been brought to 204 or 205 species, one or two records being somewhat doubtful, but other species will probably be added before the list is finally completed. Many of these are of course very rare or even of accidental occurrence. Yet fully half the number may be considered regular and quite common, while sixty or seventy are easily possible for the observing amateur to list in the course of any week of the tourist season. I know of localities where on any fine day of the season from twenty to thirty species may be seen in the course of a two-hour walk. For, tho our park bird life is not marked by either abundance of species or density of bird population in general, it is nevertheless true that in many favorable localities there is concentrated a community of birds which, both in diversity of species and number of

individuals, might be considered rich in any region.

DIVERSITY OF SPECIES

While it must be admitted, and has been admitted, that our avifauna is not distinguished by general abundance, it is just as true that the birds we have show a very remarkable range in classification. Indeed, the range could scarcely be greater; for the utmost extremes are actually represented, -- by grebes on the one hand and thrushes on the other. These represent, respectively, the Orders Pygopodes - diving birds and Passerers - perching birds. All but three of the intervening fifteen Orders of North American birds are represented in Yellowstone Park; the omissions being the Tubinares - tube-nosed swimmers -, Odontoglossae - flamingoes -, Psittaci - parrots and parrot-like birds. Thus it is seen that even so pelagic an order as that containing the frigate or man-o'-war-bird is represented; in this case by the white pelican. Of the order of perching birds, every one of the twenty families is represented.

RESIDENTS AND MIGRANTS

As to the status of Yellowstone birds when divided according to time of appearance or residence, they show no pronounced general departure from what is general with the bird life of lower and more uniform altitudes. Thus, crows and jays are permanent residents, as are our grouse and certain woodpeckers; our thrushes, swallows, flycatchers and humming-birds are summer residents; our shore-birds are partly summer residents, partly migrants; our grosbeaks, cross-bills and waxwings are rather wandering, local and irregular somewhat as in their eastern range, tho their status is more nearly that of permanent residents in the park. Finally, we have the snow bunting, redpoll, bufflehead duck as winter visitants. However, the thermal springs and streams create conditions which are peculiarly

reflected in our bird life in certain cases.

SNIPE AND KINGFISHERS AS ALL WINTER BIRDS

It may sound weird to say that one can go out on snow-shoes in the coldest day of January, confident of flushing Wilson snipe or "jack" snipe, as they are called by shooters. Yet, such is the fact; and it illustrates the general weirdness of this park area from an unfamiliar angle; for it is just as much a freak of nature, in the ornithological field, as the geyser or the mud-pot is in the geological domain. The belted kingfisher and the red-shafted flicker are two more permanent resident species which owe this unusual status to the influence of thermal springs and streams. The vegetation along or about these warm water areas is kept green all winter and with this condition is undoubtedly correlated the presence of the usual low forms of life in an active state, so that the snipe and other birds find an abundance of marine and other insects for food, while the kingfisher always finds open water in which to fish. The mallard duck, green-winged teal, and perhaps an occasional other species of duck usually a summer resident in our northern states, are also permanent residents in the park. This is also due to the fact that there is always open water in our warm streams and ponds.

ABUNDANCE OF PREDATORY BIRDS

The Order Raptores, or Birds of Prey, is represented in the park by an exceptional abundance of individual birds and quite a range of species. Our form of the eastern "hen hawk" (the larger of the two species commonly so-called) is the Western red-tailed hawk. This species, with one or two others of similar size and general appearance, occurs as a summer resident and predominates among the birds of prey if we make an exception of the little sparrowhawk whose robin-like size keeps him out of the

limelight and conceals his predatory nature. Now, the reason for the great number of hawks of the red-tail's type is doubtless to be found in the person of the Kennicott ground squirrel, spermophile or, as it is better known in park phraseology, "picket pin" or "gopher". These little mammals constitute the chief staple of the Red-tail and his congeners, as food for adults and young alike. When it is considered that thousands of these hawks depend on the ground squirrels for perhaps two-thirds of their total summer food supply, it can be better understood why the little picket-pin, — already occuring in hundreds of thousands if not in millions, — does not actually exist to the exclusion of all other animals. However, it must not be thought that the hawks wholly account for Nature's balance in the case of the ground squirrel. The badger, mink and weasel are important factors in keeping the number of picket-pins reduced to even their present teeming multitudes.

INTERESTING WATER-BIRDS

It may be news, to more than one layman, that Yellowstone Park, so high and dry in general, is particularly blessed with water-birds. Not only are there exceptional numbers of ducks, geese and waders, but grebes, bulls, terns and pelicans; so that, if one were to view a collection of Yellowstone water-birds on a museum shelf, accompanied by nothing but their conventional wooden stands, he might well think the collection represented some coastal or at least sea-level area. Nothing there would suggest that those birds could have come from an inland and mountainous region. For, the latter general condition is rendered largely null by the myriad streams, lakes, springs, swamps and wet meadows of the park. We cannot by any means here attempt to discuss all the species, or even very many of those which are most interesting; but a few are so

exceptional that they cannot well be passed over without brief but particular mention.

SOME NOTEWORTHY DUCKS AND GEESE

Several things combine to make the Barrow goldeneye duck the most noteworthy water-bird in Yellowstone Park. Generally quite rare in the United States even in winter, and spending its summer chiefly in the far north where it breeds, Yellowstone Park contains a goodly share of the high, secluded little lakes which alone constitute its breeding area within Uncle Sam's domains. The goldeneyes are called "whistlers" by sportsmen, owing to the whistling sound made by the wings in flight. The sound is doubtless due to a somewhat smaller wing spread in these ducks than in others in comparison with weight of body. The goldeneyes nest on hollow trees, often twenty or more feet from the ground. The male Barrow goldeneye is a strikingly marked black and white bird; the female is grayish in general, wings blackish, heavily barred with white. The male has a rather large halfmoon patch of white near the bill on the side of his otherwise glossy black head. Another far-northern duck is the harlequin. Unlike the goldeneye, the Harlequin is not known to breed in the park. It is known here as a winter visitor in limited numbers. Its favorite haunt is in the swiftest streams, and particularly the Yellowstone River. As his name implies, the harlequin is a showy individual, particularly for a duck, -- or rather, for a drake; the female of the species being quite modestly clad, -- and he is one of the least timid of all; apparently he likes to display his remarkable color scheme of slate-blue, orange-chestnut, white and black. Among other winter ducks we have the buffle-head and the scaups or "blue-bills" of the hunters. The river ducks (those which dabble for their food instead of diving) are numerous. Mallards and green-winged

teal are the most common; but widgeon, pintail, shoveler and the beautiful cinnamon teal are not rare. The queer little ruddy duck is also one of our common summer residents. Canada geese are very abundant and "tame". They nest in the park, and at least many of them are permanent residents. During their migrations, flocks of snow geese visit the rivers and meadows, beautiful in their white plumage which is intensified by the jet black tips of the wings.

EAGLES

Eagles are always of interest. The King of Birds! The American Emblem! These synonyms come at once to the mind, consciously or otherwise, at mention of the word "eagle". Yellowstone Park boasts both the bald and the golden species. The former, our national bird, is a resident except for two to three months of the winter. In summer it is especially numerous on the shores of Yellowstone Lake where it nests in the tall trees. Following the shore-line in a boat, one may sometimes count six or eight eagles in the space of a dozen miles. In the colder months these birds disperse to all parts of the park, especially to the lower and medium levels, where winter-skilled animals form a staple of their food supply. The golden eagle seeks for its summer residence the higher elevations, nesting on the wildest and most inaccessable mountain ledges, so that the tourist seldom sees it. But, like the Bald, it wanders widely over the park at other times. It is a permanent resident and, even in the coldest weather of January and February, it is sometimes found held fast in a coyote trap set beside a dead horse or elk. There is little difference in the size of the two species — not enough to be appreciable in the field. In identifying the birds it should also be borne in mind that the immature bald eagle has a dark head and tail, thus lacking the chief out-

ward marks by which the adult is known. It is seldom that one can surprise these birds or approach them so closely that the difference in the legs may be noted. The feathers extend down to the toes of the golden eagle; only to the heel (what appears to be the knee) of the bald eagle. The bald eagle feeds mainly on carrion, the golden more largely on prey of its own killing. Neither species is of any danger to human life. Possibly a child under three or four months of age, if placed beside a golden eagle's nest and left to its own devices, might be attacked by the owners of the nest. But my judgement is that it would probably die of exposure first.

THE OSPREY

Our park does, indeed, boast still another "eagle", and this is the loudest boast of all, the unofficial and inaccurate. It has long been the custom of 'bus drivers to call the birds "eagles" which nest on the pinnacles in the Canyon and on so-called "Eagle-nest Rock" between Gardiner and Mammoth Hot Springs. These birds, however, are all ospreys. They return year after year with almost clock-like regularity to their time-honored summer homes. Since the establishment of this area as a National Park in 1872 not a single year has been known to pass without its pair of ospreys and their nest on the miss-named Eagle-Nest Rock. Probably that statement also goes for most of the ospreys, nest-bearing pinnacles in the Yellowstone Canyon as well. The osprey feeds as its common name, "fish hawk", implies. Much of its food consists of fish found dead, but it also takes a toll of live prey from the water, plunging from a height and grasping the fish with its talons. The latter are very long, sharp and hooked. The entire under side of the toes is provided with remarkably developed spicules --- sharp spurs for holding

the slippery prey.

CHARACTERISTIC YELLOWSTONE BIRDS

While there is no species of bird peculiar to the region; that is, found in Yellowstone Park and nowhere else, there is, as we said before, so fine a representation of typical Rocky Mountain birds that this may be regarded as the chief feature of our avifauna; this particularly for a region so far east of the Pacific. The tourist from the Atlantic states must travel almost, if not quite, as far as the Yellowstone Park before he will find so closely associated the Clarke nutcracker, black-headed jay, Rocky Mountain jay, northern raven, Lewis woodpecker, water ouzel, rosy finch and Townsend solitaire, — not to mention the Barrow goldeneye duck, cinnamon teal and others. It is difficult to say which is the most characteristic bird of the park; but doubtless it is one of those just named — perhaps the Townsend solitaire, especially if something is allowed for a species typical of the Rocky mountains. This gray, thrush-like bird, in size about the equal of a hermit thrush, is too timid, solitary and silent to attract general notice; yet the bird student will find him quite common and will come to associate him with miles of lodgepole forest, forest-clad streams and mountain slopes. The Clarke nutcracker or Clarke crow at once attracts attention of the "tenderfoot", and the eye or ear of the latter 'registers' a new bird. For, the ashy gray body and jet black wings and tail of the nutcracker are no less striking than his harsh, distinctive notes. The outer tail feathers and a patch on each wing are white, alike in male and female. Tho this bird is sometimes called "camp robber", these terms are more often and more justly applied to his sometime associate, the Rocky Mountain jay. The latter is about the size and general shape of the blue jay

of the east; but there the comparison ends, for instead of the attractive dress of his eastern cousin, the camp robber wears a plain coat of dark gray, darker above than below; the head is nearly white, with a blackish nape. The camp robber seems to crave attention, and he succeeds in spite of his unattractive garb. About the time the tent is pitched or the long-unused snowshoe cabin is opened to the unaccustomed air the camp robbers begin to be seen prying about. On soft, noiseless wing they swoop gracefully down to points of vantage, ready to hop about the campfire or the door-sill of the cabin as soon as crumbs, bacon rinds or other scraps are tossed aside from the first meal; these they pounce upon and at once eat or bear away to a nearby branch. The black-headed jay is the "blue jay" of the natives, -- a handsome bird, indeed, much longer of crest and much darker of tint than the eastern bluejay. The raven is common. He bears a close general resemblance to the crow, but is larger and utters various croaking calls, but never the "caw-caw" of the crow. Crows are about as numerous as ravens in the park, so that very favorable opportunities are offered to compare the two. After all, it is perhaps the little water ouzel which, of all Yellowstone birds, most deserves special mention.

## THE HIGHLY INTERESTING WATER OUZEL

The ornithologists place the water ouzel in a family by himself; he has no near relatives -- not even a second or third cousin by marriage -- among our feathered friends. And, indeed, he is an odd fish among birds. About the size of a robin which has lost its tail, the color of a catbird, the shape of a corpulent wren, the ouzel even at first glance impresses one as having "that different" look. When it is added that he sings more in winter than in summer, builds a hut-like nest with the entrance almost

thru the floor and, that, -- tho a land bird and without webbed feet, -- he swims with the ease of a duck; -- then his many-fold claim to attention becomes more apparent. Yet that is not all. This feathered anomaly, this land bird, walks and gathers his food on the bottom, under the water, of a swift-flowing mountain stream with all the nonchalance of a robin hunting worms on a green grassy lawn! There are always a few pairs of ouzels nesting between the north entrance and Mammoth Hot Springs. Here the nests are placed on rocks in or beside the Gardiner river and from two to four feet above the water. In some other localities in the park the nest is situated more fully in the spirit of the bird -- high on the straight or overhanging side of a cliff over which a stream falls, keeping the mossy nest green in the constant spray. The water ouzel is most often to be seen on the rocks in mid-stream or at least against a background of rushing water, -- a dark, solitary little figure who bobs up and down at frequent and regular intervals and would look vastly more dignified if only he had a much longer tail. To that bobbing habit the ouzel owes one of his common names -- "dipper". While we are on the subject of interesting and unusual birds mention should be made of the phalaropes.

PHALAROPES

These are small, swimming snipe. Two species, the northern and Wilson are found here during their migrations, especially in the fall; one or both may very possibly nest sparingly in the park. These birds are usually seen swimming about like miniature ducks on some pond or lake. They are about the size and shape of a spotted sandpiper. In this group it is the females which wear the bright feathers, while the males are clad in the more sober tints. Correlated with this reversal of the usual rule,

the dull-colored male phalrope hatches the eggs and cares for the young, while the gayly bedecked wife and mother gads about and leads a life devoid of care and responsibility.

THE WESTERN OR LOUISIANA TANAGER

This is our representative of the gay scarlet tanager of the east and the summer tanager of the south. Not even those species --- famous as they are for exceptional beauty, where fine feathers are so dominant a note in the bird life --- surpass our western tanager in attractiveness, tho the color scheme of the latter is widely different from that of either of the other species mentioned. The male of our bird has a bright yellow body, jet black back, wings and tail, the wings barred with yellow and edged with white; the face is orange-red. The female is yellowish, olive and gray. The notes of this tanager, like those of the scarlet tanager, are rich and pleasing.

MISCELLANEOUS FACTS

The largest birds in the park are the trumpeter swan, white pelican and eagles; the smallest are the humming-birds. We have at least three species of the latter, so near alike in size that it is like splitting feathers, if not hairs, to be specific in the matter of size. The most attractively colored bird is the western or Louisiana tanager. The most abundant species cannot be determined with certainty. The mountain bluebird is apparently more abundant in summer than is any other species at any other time of the year. The Clarke nutcracker seems to be the most abundant species in winter. The rarest species is also a problem, for no one can say with finality just which of certain seldom-recorded birds are "rare", "casual" or "accidental". But, of the species which are to be found here every year, the trumpeter swan is perhaps the rarest; yet

there are several rivals for that questionable honor, for examples, --- the harlequin duck, duck hawk, kingbird and catbird. The most important species is another elusive character. All are necessary to maintain Nature's balance. Economically, the western red-tailed hawk comes to the forefront -- the chief enemy of the ground squirrel. From the standpoint of direct interest to the greatest number of tourists, the osprey is doubtless the most important. He would be missed more than any other one species of bird.

BIRD COMMUNITIES

The writer has mentioned a feature of our bird life -- the concentration of birds in certain favorable localities. Space here does not admit of much detail, but I will cite two examples. There is a small lake or pond near Junction Butte which is especially rich in water-birds. Here, in the open water or among the flags which border it, are often to be seen Canada geese, mallard, green-winged teal, Barrow goldeneye ducks, ruddy ducks, coots grebes, a colony of yellow-headed blackbirds. Western meadowlarks are especially numerous in the immediate neighborhood. Only half a mile from this little lake, nearer Junction Butte and directly bordering the Cooke City road, is an aspen grove which is highly favored with small birds. Within a three-acre space are to be found, nesting, the red-shafted flicker, the tree swallow, western warbling vireo, mountain bluebird and doubtless the sparrowhawk and other species. Camp Roosevelt is another good locality. The woods about this camp are populous with interesting birds;- flickers, nutcrackers, western tanagers, chick-a-dees, nuthatches, juncoes, chipping sparrows, robins and others abound. The wonderful song --- wonderful especially for so small a musician -- of the rubycrowned kinglet comes from the woods all about. Morning and evening you can hear from the porch, with

unfailing regularity, the song of the Audubon hermit thrush, -- the finest bird voice in the park.

HINTS ON FINDING AND NAMING BIRDS

The following brief remarks are taken from the present writer's book, "Land Birds of Northern New York". They apply as well to bird study in Yellowstone Park as anywhere else. "Carry a pencil and pocket memorandum book and use them on the spot. A field glass or an opera glass is a great help. It is best to dress plainly and well to wear stout waterproof shoes. If the sun shines brightly try to keep it on your back, so that your birds when first seen, shall be in a favorable light", your first glimpse of an elusive bird is of utmost importance, for it may be your last; hence the great importance of good initial lighting on your subject. The earliest and latest hours of daylight are best, morning preferred for most species. "Above all, aim to see particularly and distinctly. General and inaccurate impressions are of little or no use". When still in doubt of a species, consult a Ranger Naturalist or Naturalist Guide. "The study of birds in the field calls for great patience, just a reasonable amount of caution and, of course, common sense."

(Signed) Edmund J. Sawyer

ANTLERED OR OTHERWISE HORNED ANIMALS OF YELLOWSTONE PARK

ELK DEER MOOSE MOUNTAIN SHEEP BUFFALO ANTELOPE

Compiled by: Ranger Marguerite Lindsley

Approved by: June 1, 1926.

Dr. Wm. T. Hornaday, New York State Zoological Park, New York,
Dr. Joseph Grinnell, University of California, Berkeley, Calif.,
Superintendent Horace M. Albright,
Mr. E. J. Sawyer, Yellowstone Park Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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Horns; (Webster) "The processes borne on the heads of many ungulates (hoofed mammals) and used chiefly as weapons of offense or defense. The term includes structures of several distinct kinds, sometimes median in position, but usually lateral and paired. Those of cattle, sheep, goats and true antelopes are unbranched and permanent and usually present in both sexes. They consist in a bony sheath of epidermal substance (tough, fibrous material of which true horns are composed) supported by a bony core. Those of deer, specifically called antlers, are solid, bony, usually branching outgrowths, which are shed and renewed annually, and are present usually only in the male. Those of the pronghorn are in some respects intermediate between the above types. --"

Antlers; (Webster) "The entire horn, or any branch of the horn, of an animal of the deer family. Antlers differ from the horns of other ruminants (hoofed animals which chew the cud) in being solid, generally branched, bony outgrowths, shed and renewed annually. Usually they are present only in the male, but also in the female of the reindeer and caribou. When growing they are soft and covered with a downy, vascular

covering, the velvet, which afterwards wears or is rubbed off. The main stem is called the beam; the branches, the tines or points. The latter are generally more numberous in older animals, horns of young bucks being simple spikes.--"

Pronghorn: (Webster) "A peculiar ruminant confined to the treeless parts of the western United States and Mexico. It is not a true antelope, but the sole representative of a distinct family (Antilocapridae). The color is chiefly a yellowish tawny above and white below, with a white rump patch and a tawny collar. The horns, which are present in both sexes, and furnished with a single, anterior prong, are hollow and set on a bony core as in the oxen, goats, etc., but are shed annually, as in the deer. It is now much reduced in numbers.

It is interesting to note that the true horns are spoken of as a "horny sheath of epidermal substance, supported by a bony core" and are comparable to the fingernails or to the hair or hoofs, processes of the skin. And on the other hand we have the antlers which are composed of bone and are processes of the skeleton.

In Yellowstone National Park the horns of the mountain sheep and of the buffaloes are the only true horns. Those of the elk, deer, and moose are true antlers. Those of the pronghorns, or antelopes as they are called, are the intermediate ones described by Webster in the above. The pronghorn is the only hoofed animal in the world that ever sheds its horn-sheath.

The antlered animals, elk, deer and moose, shed their horns in the very early spring or late winter, in February or March usually, and immediately thereafter the new ones start to grow. During the time that the horns are growing they are soft and spongy and are covered with a thick layer of skin, and the whole structure is richly supplied with blood vessels and nerves. The blood is the building agent and the nerves keep the growing horns very tender, so that the animal will not use them nor even touch them against anything hard if he can avoid it. Thus they are carefully protected against injury while they are still soft. The horns are fully grown in late August or September but the protecting skin does not dry up and start to peel off until the last of the month of September. Then the animals rub them against trees and bushes, stripping off the dead skin and leaving the new, sharp antler fully grown, ready for the fighting season.

All American horned animals have hoofs, but all hoofed animals do not have horns. We immediately think of the horse and the pig. All of the native hoofed mammals in Yellowstone National park are ruminants, chewing the cud.

(Signed) Marguerite Lindsley

A PARTIAL LIST OF ANIMALS OR YELLOWSTONE NATIONAL PARK

Including the names given the males, females and young of each.

June 1, 1926.

For authorities please see footnote on last page.

| ANIMAL | MALE | FEMALE | YOUNG |
|---|---|---|---|
| Antelope | buck | doe | kid |
| pronghorn | | | |
| Badger | | | |
| Bat | | | |
| Bear | "boar" H | "sow" H | cub |
| Beaver | | | |
| Bison | bull | cow | calf |
| buffalo | | | |
| Bobcat | "tom" G | | "cub" H |
| | | | "kitten" G |
| Buffalo | bull | cow | calf |
| bison | | | |
| Catamount | "tom" H | "lioness" G | "cub" H |
| | "lion" G | | "kitten" G |
| cougar | | | |
| mountain lion | | | |
| painter | | | |
| panther | | | |
| puma | | | |
| Chipmunk | | | |
| Cony | | | |
| pika | | | |
| rock rabbit | | | |
| Cougar | "tom" H | "lioness" G | "cub" H |
| | "lion" G | | "kitten" G |
| Catamount | | | |
| mountain lion | | | |
| painter | | | |
| panther | | | |
| puma | | | |
| Coyote | "dog" H & G | "bitch" H & G | cub |
| | | | "pup" H & G |
| prairie wolf | | | |
| Deer | buck | doe | fawn |
| Elk | bull | cow | calf |
| wapiti | | | |
| Ermine | | | |
| weasel | | | |
| Fish | | | "minnow-fry" G |
| Fox | dog | "bitch" H | "cub" H |
| | | "vixen" G | "pup" G |

Marguerite Lindsley

| ANIMAL | MALE | | FEMALE | | YOUNG | |
|---|---|---|---|---|---|---|
| Gopher | | | | | | |
| ground squirrel | | | | | | |
| picket pin | | | | | | |
| Ground Hog | | | | | | |
| marmot | | | | | | |
| woodchuck | | | | | | |
| Ground Squirrel | | | | | | |
| gopher | | | | | | |
| picket pin | | | | | | |
| Lynx | "tom" | G | | | "kitten" | H & G |
| Marmot | | | | | | |
| ground hog | | | | | | |
| woodchuck | | | | | | |
| Marten | | | | | | |
| Mink | | | | | | |
| Moose | bull | | cow | | calf | |
| Mountain Lion | "tom" | H | "lioness" | G | "cub" | H |
| | "lion" | G | | | "kitten" | G |
| catamount | | | | | | |
| cougar | | | | | | |
| painter | | | | | | |
| panther | | | | | | |
| puma | | | | | | |
| Mountain Sheep | ram | | ewe | | lamb | |
| Mountain rat | | | | | | |
| pack rat | | | | | | |
| Muskrat | | | | | | |
| Otter | | | | | "pup" or | |
| | | | | | "kitten" | G |
| Pack rat | | | | | | |
| mountain rat | | | | | | |
| Painter | "tom" | H | "lioness" | G | "cub" | H |
| | "lion" | G | | | "kitten" | G |
| catamount | | | | | | |
| cougar | | | | | | |
| mountain lion | | | | | | |
| panther | | | | | | |
| puma | | | | | | |
| Panther | "tom" | H | "lioness" | G | "cub" | H |
| | "lion" | G | | | "kitten" | G |
| catamount | | | | | | |
| cougar | | | | | | |
| mountain lion | | | | | | |
| painter | | | | | | |
| puma | | | | | | |
| Picket Pin | | | | | | |
| gopher | | | | | | |
| ground squirrel | | | | | | |
| Pika | | | | | | |
| cony | | | | | | |
| rock rabbit | | | | | | |

Marguerite Lindsley

| ANIMAL | MALE | | FEMALE | | YOUNG | |
|---|---|---|---|---|---|---|
| Pole Cat | | | | | kittens | |
| skunk | | | | | | |
| Procupine | | | | | | |
| Prairie Wolf | "dog" | G | "bitch" | G | "cub" or "pup" | H |
| | | | | | "pup" | G |
| coyote | | | | | | |
| Pronghorn | buck | | doe | | kid | |
| antelope | | | | | | |
| Puma | "tom" | H | "lioness" | G | "cub" | H |
| | "lion" | G | | | "kitten" | G |
| catamount | | | | | | |
| cougar | | | | | | |
| mountain lion | | | | | | |
| painter | | | | | | |
| panther | | | | | | |
| Rabbit | | | | | "kitten" | H |
| Rock rabbit | | | | | | |
| cony | | | | | | |
| pika | | | | | | |
| Skunk | | | | | kitten | |
| pole cat | | | | | | |
| Squirrel | | | | | | |
| Wapiti | bull | | cow | | calf | |
| elk | | | | | | |
| Weasel | | | | | | |
| ermine | | | | | | |
| Wolf | "dog" | G | "bitch" | G | "pup" | G |
| Wolverine | | | | | | |
| Woodchuck | | | | | | |
| ground hog | | | | | | |
| marmot | | | | | | |

Footnote:
This alphabetical, partial list of the animals showing some of the synonyms was compiled first with the aid of Websters Standard Dictionary and copies were sent to Drs. Wm. T. Hornaday of the New York State Zoological Park and Joseph Grinnell of the University of California for their corrections and suggestions. Quotations were placed there by those men and their initials follow each correction or addition made by them. Where they differed both authorities are given. Dr. Hornaday gives as his final authority the Century Dictionary.

Ranger Marguerite Lindsley.

Approved by:

Superintendent Horace M. Albright,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

# PREDATORY ANIMALS OF YELLOWSTONE NATIONAL PARK

This story was compiled by Marguerite Lindsley, a park ranger, and criticised and amended by the following men: Superintendent H. M. Albright, Acting Director of the Museum J. E. Haynes, Park Naturalist E. J. Sawyer, Chief Ranger S. T. Woodring, Dr. H. S. Conard, Dr. F. E. A. Thone, and Mr. M. P. Skinner.

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Predatory or Predacious; (Webster) "living by preying upon other animals".

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In Yellowstone National Park, the largest wild animal sanctuary in the United States, the subject of predatory animals is of considerable importance, in that only predatory animals are destroyed by authority of the Federal Government, and then only by the Government employees.

There is being raised more and more, the question as to the advisability of killing off all of any one species of the predatory animals in a game preserve. It is thot by some that this would be harm by so disturbing the equilibrium of nature that some undesirable condition might result. All animals, strictly predacious according to the definition, are not being destroyed in Yellowstone Park. Those shot here are the coyote or prairie wolf, the timber wolf or lobo as he is sometimes called, and the mountain lion, known also as the cougar, puma, panther, painter, or catamount.

The policy of the National Park Service is not to <u>exterminate</u> predatory animals or birds. The animals that do the most damage are to be reduced, particularly in the areas where they are likely to do

the greatest harm. For instance, the rangers concentrate on the killing of coyotes in the northern part of the park because they are so destructive to young antelope and that is their range.

The larger mammals here are the deer, elk, antelopes, mountain sheep, moose, and buffaloes. The last two are especially well able to protect themselves and their young, and it is only when an individual is not as healthy as he should be, or when the young ones become separated from their mothers, or the individual is injured, that there is danger from the larger predatory animals.

Of the rodents or gnawing mammals, we have in the park, more representatives than of any other group. They are represented by the following: ground squirrel, marmot, chipmunk, mouse, pack rat, cony, rabbit, muskrat, beaver, porcupine, ~~[illegible]~~, and squirrel. Most of these are represented by more than one species; for instance, under the heading of the rabbits we find jack rabbits, snow-shoe rabbits, and cotton-tails.

In further discussing predaciousness in the park let us first consider the birds. The bald eagle, the National Bird, is disappointing in much the same way that the lion is disappointing as the "King of beasts". The lion is a coward and the bald eagle is a carrion eater,- a meat eater that kills very little of his own food, and a robber, having been known to steal fish caught by the osprey. The golden eagle, however, is a permanent and not an uncommon resident in the park. This species usually kills its own prey and is therefore, of much more noble standing than the ill-chosen national emblem.

The fact that the mountain sheep do not increase any more rapidly in the park has been attributed to the activity of both species of the eagles. Careful observers are of the opinion that a large number of young sheep and young antelopes are killed annually by the eagles. The mother deer carefully protects her young from predatory enemies, but antelopes and sheep leave them "under cover" for hours at a time, and upon being exposed to view, as they often are, they become the easy prey of predatory animals or birds.

As to the hawks. First we have the osprey, or fish hawk, which lives almost entirely on fish which he usually catches alive in the streams or lakes. There are other hawks in the park whose prey consists of rodents, insects, reptiles, and small birds. There are also owls, whose diet is much the same as that of the hawks, consisting chiefly of rodents, birds, reptiles, insects, frogs, and toads.

Among the fish-eating birds besides the osprey, we find of foremost importance the pelican, that well known glutton which eats daily a large number of fish; then the merganser, or fish duck, and several other species of ducks found on park waters are large consumers of fish. Finally we come to the great blue heron and the belted kingfisher, the former living to a great extent, the latter almost entirely on fish.

Now we will take up the predatory mammals. First and best known is the coyote which lives almost entirely on rodents,- gophers, mice,

chipmunks, rabbits, and all, but which will always kill one of the larger mammals if the opportunity presents itself in the form of a straggling, sickly calf elk, deer fawn, young antelope, or even a calf buffalo. In the winter each buffalo herd has a following of coyotes, two or three of them always within sight and often very near, watching for the sick or disabled, or for the old timer to go off by himself to die; these are the coyotes' feast. In the same family are the fox and the wolf, the former much smaller than the coyote and not so clever, the latter larger and with much greater strength. These two are both nearly all gone from the park now and are very seldom seen by the winter rangers.

As to the cats; these are first, the mountain lion, catamount, cougar, puma, panther, painter, as you wish to call him, and the lynx, the bay-lynx or bobcat. Both of these animals are fond of any fresh meat but perhaps they are not so vicious as they are often pictured. They are extremely curious and very stealthy and stories of their following people are quite probable. As to the fact of their being able to leap great distances thru the air, there is no question about it. "Agile as a cat" is a phrase based on a fact. The mountain lion ordinarily kills all but the largest of the larger mammals, and also rodents and a few birds. The lynx is not far behind in prowess tho much smaller in size, but lives primarily upon the snow-shoe rabbits of the wooded districts. These animals also are nearly all gone from the park. The very fine mounted specimen of a mountain lion in the Museum is an animal which was caught in the winter of 1924-25 by

Chief Ranger Woodring and others.

The badger is a small animal, not much larger than a good sized marmot, and he is extremely bloodthirsty, living most of the time on gophers, marmots, and other small rodents. The weasel, or ermine as he is in winter, and the marten or pine marten, are bith carnivorous little animals that live on small mammals and birds.

The skunk or "polecat" is another meat eater, living on young rodents, frogs, insects, and an occasional bird.

The otter and the mink are both aquatic, the former much more so than the latter, and are oftenest found along some stream, fishing. The otter lives almost entirely on fish but the mink eats many small animals and birds. Both the otter and the mink have a lust for killing far in excess of their needs. They fish largely in the smaller streams as there the fish have less chance of escape than they do in the larger rivers.

Of the bears, the grizzlies are more apt to be killers than the blacks (including the browns and "cinnamons") but none of them do much in that line in the park, being naturally lazy and not at all particular about their food. They are undoubtedly happiest when eating and they will eat anything and everything in sight at any time. None of the bears are considered predacious.

The only large snake found in the park is the bull-snake, a big snake

marked quite a bit like a rattler (of which there are none in the park), not only entirely harmless to man, but really a beneficial snake, altho predacious in the strictest sense of the word. The bull-snake lives on rodents, frogs, insects, and other snakes.

This concludes a preliminary discussion of the birds and animals of prey as they are found in Yellowstone National Park.

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Completed April 6th, 1936.....

FOUR MILE NATURE STUDY HIKE AT MAMMOTH HOT SPRINGS-

Season 1925 Ranger Dorr Yeager

Revised to date and approved by: May 30, 1926.

Superintendent Horace M. Albright,
Dr. H. S. Conard, in charge of the ranger-naturalists,
Mr. E. J. Sawyer, Park Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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The buildings on your right are the homes of some of the prominent men of the park. The first one is the Haynes Picture Shop where you can get films if you want to. We will go slowly for the next block and give any who wish to get films a chance to catch up. The next building is the home of Mr. Nichols of the Yellowstone Park Hotels Company. The next building is the summer home of Mr. Child, the owner of the hotels.

This will give you the first view of the formations. This one is Hyman Terrace, very delicately colored and is building toward the north. Straight across, the high pointed formation is Liberty Cap. It may have been at one time much larger than that, and have been worn down by erosion. Liberty Cap is really the inner core of an extinct hot spring. There is a hole or crevice up the center where the water used to bubble out bringing with it different minerals in solution, and as it ran down over the sides it threw out of solution these substances and deposited them. Then after a long time the water stopped flowing and erosion set in, wearing it down to the inner core that you see there. A little to the right of it you see another formation that is much similar to Liberty Cap in shape. That is the Devil's Thumb and was formed in the way way as Liberty Cap but is not so old. We will hit the formations at the end

of our trip but I will take this opportunity to try to tell you a little about the formation of these springs. As I said in my talk last night they are very old. Around Mammoth the formations are largely calcium carbonate or travertine. It builds up very rapidly and wears down very rapidly -- is a very soft material. Now calcium carbonate is soluble in hot water containing carbon dioxide. There are vast layers of limestone under us. The water bubbles up, dissolving the limestone and bringing it up in solution. Now if you will notice here at Hymen Terrace, the formation is in the shape of pans or steps, one above the other. That is due to the fact that the hot water containing the travertine in solution bubbles up out of the ground forming a pool. Naturally the water on the outside is cooler than the water on the inside, so the carbonate is thrown out of solution and deposited faster around the outer edge of the pool. This keeps on until the water is almost walled off by these deposits. Well, eventually the pool fills up, overflows and the water forms another pool down below it. The process is repeated. That gives us the effect of pans or steps and if you will notice you will find that practically all of the formations here at Mammoth are built up in that way.

Now about the coloring in the formations. You may have heard that it is due to chemical coloring but it is not. The coloring in all of the springs, or practically all of them, is due to algae, which are microscopic water plants. The different colors represent different species and these different species grow in the different temperatures of water. So you can be pretty sure that every different color represents a different temperature of water. The grey part on beyond Liberty Cap is all

dead formation -- that is, there are no active springs on it. The algae can only live in the water and as soon as the water stops flowing the algae die, and the color fades. We call that dead formation. There is just one other thing about the formations and that is about walking on them. I'll have more to say about that later but I'll just say here that the formations are very delicate and when they are broken they can never be replaced, so please be careful about throwing sticks or anything on the formations and above all, be careful where you step.

The buildings back of you are the old Fort Yellowstone buildings. Up to 1916 this park was patroled by soldiers and Mammoth Hot Springs was Fort Yellowstone which played an important part in the history of the early northwest. The buildings were the homes of the commissioned and non-commissioned officers of the old fort. They are now occupied by the park officials;- the superintendent, assistant superintendents, chief electrician, chief engineer, a ranger station, post office, museum, information office etc. The large open space between us and the buildings was the parade ground of the old fort.

WE're going up the Sepulchre Mountain trail. As I said last night it isn't a hard trail. It is a steady climb for the first mile but we are going to rest several times between here and the top and we're going to take it slowly. I don't know how many of you have done any climbing before but for the sake of those who have not I'll tell you what I find to be the easiest way. If you'll take slow, uniform steps -- the best way I can describe it is by slow motion pictures. Take the slow uniform steps and keep it up. It isn't climbing that tires a person so much as

sudden motions. Running along ahead, sitting down and resting and then running on ahead again -- that's what tires you out. Also when you are going up a steep grade lower your hips and cut down the length of your steps, -- I think you'll find that helpful. There's just one other thing I want to say before we start. I want to take the lead when we start and I want to keep it thruout the trip. There are two reasons for this. First, if I find something I want you to see and someone is fifty yards ahead of the party I'm going to have to waste a lot of breath calling him back and he's going to have to travel an extra hundred yards; and second, if there's any animal on the trail he will be the only person to see it and will ruin the chances of the rest of the party for seeing it. So I want it distinctly understood before we start.

I'm going to ask you to cooperate with me in this hike. This is a nature study hike and naturally different people will see things they want to know about, -- now there are lots of things on this trail that I don't know about and I am going to be free to tell you if I don't know -- if I am free to tell you if I don't know, you should feel free to ask me anything you don't know about, - so if you see something that interests you and I don't call your attention to it, just call my attention to it and I will do my best to help you out. Let's go,

Five minutes. Better sit down and get off of your feet. You passed several flowers on the trail as we came up that stretch. The fairly high ones looking like little blue stars are false forget-me-nots or stick-seeds. The white ones about eight inches high were wild geraniums

and the pink ones the same shape as the white ones are also wild geraniums of a different species. The big, flat umbels of white flowers that you saw about half way up -- there are some over there across the creek -- are cow parsnips. The ones that look like brown-eyed Susans are helianthella or mountain sunflower. You will see a lot more flowers as we go on up and it is interesting to see the change in flora as we go higher.

You will notice several different kinds of trees on the trail. We see four kinds of evergreens on this trip. The Douglas firs, the spruces, the pines and the junipers. I'll tell you a little about them now and then I'll show you the difference farther up. The pines are always characterized by having the needles coming out in bunches ranging from 2-5 needles in a bunch, depending on the species. The spruces have the needles spirally arranged and coming out one in a place. The fir -- that is the Douglas fir, this big one we are sitting under, has the needles coming out one in a place, but the needles are flat and rather soft while in the spruce they are stiff and hard. There is another way of telling a Douglas fir-- if you get a good sample you'll see that the leaves are on both sides of the stem and don't go clear around as they do in the spruce. Somebody the other day said, "It looks as if he had his hair parted in the middle." Well it does look a lot that way and you'll see the resemblance when you get a good specimen. Now the other evergreen is the juniper. I can show you a juniper better than I can tell you about it. Time to go.

Now this is one of the junipers I spoke about back there. This is the

erect form, Juniperus scopulorum. We will have to wait a little while before I can show you the other species. Notice those trees with a blue tint over in the ravine to your left. Those are Colorado blue spruces. They are used in town a lot for landscaping and if you've ever bought them you can appreciate them here. They cost from $5. to $15. from the nurseryman-- we grow them out here for nothing. All right, another five minutes.

This water is all right to drink but take it easy. It's the last water you will get for some time but don't drink too much -- I don't want to have to carry anyone home. Someone asked me about this flower. That's what we call baby's breath. Anyone know a different name? Queen Ann's lace is another name for it. These trees are quaking asps, aspens and trembling aspens, are other names for them. Watch them for a moment and you'll see why they have that name. They catch the slightest breeze and quiver in it. That is due to a very peculiar construction of the leaf stem. It can move sideways where the ordinary leaf can move only up and down. Those scars on the bark are due to the elk eating the bark in the winter time, or rubbing the "velvet" off of their horns on it. I used to say it was due to the elk barking the trees but one day someone told me she didn't know elk barked. All right, time to go.

Now this next stretch is the longest of any on the trip. Notice the scars on the bark of these aspens? It is hard to find a single tree in this grove that doesn't have a scar on it. Someone reminded me the other day that it would be a dandy hiding place for a zebra. I did see a deer in here on day tho. The trees with the scars so completely camoflaged him that I would have missed him entirely if one of the party had not seen

him. Did I tell you that these trees belong to the same family as the cottonwoods? Notice the shape of the leaf and you'll see they resemble the cottonwood leaf.

The stick-seeds are surely thick up here this time of year. Notice those mushrooms up in the trees? Anyone have an idea of how they got there? Well, the pine squirrels out here are very fond of them and whenever you see a mushroom up in a tree like that you may be sure that the squirrel has dropped it. Everyone coming back there? By the way, in case you don't know what this bush is it's sagebrush. Sage tea is made of a different species from this. See that? It was a Richardson grouse.

Notice those tracks in the mud over to the left. They are deer tracks. The elk make much larger tracks than that and the elk are much higher up at this time of the year. We rest at the top of this grade for twenty minutes. All right, another five minutes.

There are several new flowers at this height. These high ones are delphinium or larkspur — yes, you cultivate them in your garden but they don't grow as high as this. The blue, sweet-pea shaped flower on a spike, this one, is mountain lupine. If anyone comes from Texas you call it "Texas blue-bonnet" down there. Then this little blue one is the harebell. Latin name Campanula. Those bright red flowers are Indian paint-brush. You may see them in different colors. I have seen them shade from white to a dark brown. Someone brought me this one. It is fireweed. It is called fireweed because it is the first flower to grow after a forest fire. The color is about the same as that of the wild geranium but the size will always

tell it. It is different in shape too. There is a red-tailed hawk--see him? If he turns just right you can see the flash of his red tail--there, get it? That is what is commonly called a hen hawk back east but it's very seldom that you'll ever find that fellow eating chickens. Time to go.

This is your last climb so cheer up. The rest of the way is down grade. This big fir tree was in a forest fire some thirty or forty years ago. The fire seems to have killed all of the other trees but this one was only scorched around the base. All right, we stop here for twenty minutes. If any of you smoke be sure to put out your matches before putting them down. Does anyone have any questions? If you do ask me and I'll try to answer them. I promised to show you the difference between the evergreens so anyone who is interested come over here. This little fellow is a Douglas fir, pseudotsuga macronate, which means false hemlock. The way to always tell one of these trees is, as I said, by the flat leaves and by the leaves going out on each side of the stem. Remember what I said about having the hair parted in the middle? This will show what I mean. Another sure way is by the cones. Notice this three-pointed appendage coming out from under each scale. That is characteristic of this tree. Now this one is a spruce and can always be told by the fact that the needles come out all over the stem and are sharp. We have two kinds here. The Colorado blue spruce and the Engelmann spruce. I once heard that the way to tell them apart was to feel the needles. If they were sharp they were Colorado blue spruce and if they were sharper they were Engelmanns. I wan't guarantee to tell the difference that way. It is very hard to tell the difference.

Now the pines are very easy because they always have the needles coming out in bunches and not one in a place as do the firs and spruces. That is the way to tell a pine when you see one. The different species are determined by the length and number of the needles. These are limber pines or pinus flexilis. By the way, does anyone know how to tell the age of an evergreen? Well a year's growth is represented by the space between two sets of branches. We call a place where a set of branches comes out a whorl and the space between whorls represents one year. For example, if this whorl grew for the year 1922, this space will represent the growth made by the stem in 1923, etc. All right, twenty minutes is up. Be sure to put out your cigarettes and ashes.

This is the best view we will get on the trail of the valley. Across there is Mount Everts, that is the valley of the Gardiner River and the north entrance lies down in that direction. Tower Fall and Camp Roosevelt are up the valley,across there is Bunsen Peak which, as I said last night, is composed largely of rhyolite, a volcanic lava. That is Snow Pass and back of us is Sepulchre Mountain. It gets its name from a large sepulchre-shaped rock on the north slope of the mountain which is visible from Gardiner but not here. From now on I wish everyone would be a little more quiet than usual because we are going to enter the timber and we will have more of a chance of seeing animals.

We are turning off now on to the Snow Pass trail. This trail leads up from Mammoth and up into the pass and out upon Swan Lake flats. Notice the soil. It is calcium carbonate. At one time the formations were this far up the hill. That must have been a long time ago because several places along here

you will be able to see signs of glacial action on rocks which shows that the formations were up here when the glaciers came. Now look where the springs are. How long it took for them to get to their present location no one knows.

From here down you will see that the soil is made up of this hot spring formation and when you strike the formations you will see that there is northing else but travertine. This is the trailing juniper of which I spoke. Take one of the berries and crush it. Recognize the smell? These are the berries from which they make gin. This bush has the latin name of juniperus siberica.

These shells are interesting. Has anyone an explanation of how these snail shells got here a mile and a half from the nearest water? No, they were not left when the water receded. If they had been they would have been destroyed and ocvered up a thousand years ago. The only way I can explain it to you is using part of the theory of evolution. These snails are land snails and are the direct descendents of the water snails that lived here when water covered this country. But as the water gradually subsided the snails adapted themselved to their new environment or perished. They wisely chose the former course and here we have a new species which is perfectly fitted to its environment. You'll find these under logs and rocks along the trail.

Now around the next turn we shall see probably a couple of mantles marmots or ground hogs. They are always up there sunning themselves and if we go quietly and don't make any sudden moves we can pass right under them. There

they are. Be careful and don't frighten them. They are very closely related to the eastern ground hog or woodchuck. Practically the same thing. Here is a bunch of fringed gentians -- the largest bunch that I know anything about in this section. Be careful of them and do not pick them because tomorrow's party will want to see them too.

Here we are at the formations. This is called Soda Spring. It's the same kind of water that you pay five cents a glass for over the soda counter except that is cold and this is warm.

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The rest of the trip is purely formation guiding and does not belong in the field of nature study, altho I always brought my nature study parties back over the formations as it was the only chance some of them had to view the springs.

This is, of course, but a rough sketch of the things covered. Things would come up in the course of the trip to vary the conversation and talk from time to time, but generally speaking, this is about the field covered daily.

(Signed) Dorr G. Yeager

QUIDE LECTURE FOR MAMMOTH FORMATIONS

Given during 1921-22-23 by Ranger Marguerite Lindsley

Revised to date and approved by: May 4th, 1926

Superintendent H. M. Albright.
Dr. H. S. Conard, in charge of ranger naturalists.
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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Introduction: None of the members of the park ranger force are permitted to accept gratuities; they do not expect fees nor will they accept them. The National Park Service provides free guide service at the principal points of interest in the park. Please feel free to ask questions, make suggestions, or give constructive criticism at any time without obligation to me. I hope you will enjoy this trip as much as I usually do.

JUPITER TERRACE: To your right you now see what is known as Jupiter Terrace which is the largest hot spring formation of its kind in existence. We usually think of water as tearing down and wearing away rock as it has done thru the years in the many canyons in this part of the world; here, however, we find it building, as high as six, seven, or eight inches, or even more in a single season.

This is a comparatively soft formation and is known as travertine. It is composed of calcium carbonate which contains also a trace of magnesium carbonate. At Old Faithful, and elsewhere in the park, the formations are called geyserite, and are composed of silica,- hydrous silica as hard as glass, known to scientists as

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silicious sinter.

Surface water seeping down thru the cracks in the earth, comes into contact with hot lava or steam rising from more deeply buried igneous rock, which, however, is comparatively close to the surface of the earth here, being only a few thousand feet below us. The hot water then rises to the surface, seeking its own level as it does in any ordinary spring. This water in its travels encounters vast beds of limestone, and because it contains carbon dioxide it is capable of taking considerable of the lime into solution. As soon as it reaches the air the gas is given off and the burden of the mineral is deposited on the surface. There are four factors which cause the deposition of this lime as travertine:

1- evolution of the carbon dioxide (carbonic acid gas).
2- evaporation of the water.
3- cooling of the water
4- extraction of carbon dioxide by the algae, tending to precipitate the mineral content of the water.

In those places elsewhere in the park where silicious sinter is being deposited, the action is very much slower as silica is so much less soluble. It takes many years to cover over a pencil mark in one of the geyser basins.

Some of the very early visitors to this region attributed the colorings to the presence of the oxides of iron and other minerals. If that were the case, how did they account for the fact that in ten days or less after a portion of that terrace dries up, as it sometimes does, there is not one iota of color left? The color

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is due, in fact, to minute bits of living organic matter, microscopic plants called algae, and they are found growing in very hot water. The algae and other primitive forms of plant and animal life found here are comparable to the most ancient life on the surface of the globe. The lighter colored species always grow in the hottest water and the darker browns, yellows and greens are found where it is cooler.

We are standing in a grove of trees belonging to the great willow family, populus tremuloides, commonly called aspen, quaking asp, or trembling poplar. Notice the small roundish leaves and the stem flattened sideways, hence the constant wiggling of the leaves. This tree is the main food of the beavers in the park. The black scars on the bark of these trees are where the elk have nibbled it when the trees were young, or where they have scraped their antlers against it when they are trying to aid in the shedding of the velvet. The magnificent antlers of the elk and deer are growing most of the time. As soon as they are shed in the late winter, growth of the new antler commences. All during this period the horns are covered with a velvet-like skin which is generously filled with blood vessels. The blunt ends are the growing points and are very sensitive and soft. Between eight and nine months are consumed during the growth period, and in the fall of the year the "velvet" splits open and is scraped off, leaving the completely formed antler. This process takes place every year in the males of both the deer and elk.

Mount Everts, the mountain facing us, is composed of limestones and shales, sedimentary rocks which were laid down in the bottom of a shallow sea which overwhelmed this area during the Cretaceous Period. Specimens of rock from the face of this mountain show fossils of the shell-fish and there is considerable coal to be found there. There is a layer of igneous rock, rhyolite, of comparatively recent date capping the southern end, while the cliff-like face of the mountain shows at its northern end two or three layers of lava embedded in the Cretaceous strata. These were forced in there in the early stage of volcanic activity in the park region. The vertical face of the mountain is due to a fault or break in the rocks. The rock over which we now stand was once on a level with the top of Mount Everts. A great split in the rock occurred, and this side fell in a distance of some 1500 feet. Just such strata as we see in the face of Mount Everts lie buried deep beneath us here. It is from these buried rocks, identical with the unburied rocks of Mount Everts, that the lime of these hot springs is taken. In the geyser region the hot water rises thru volcanic rocks instead of limestones, and hence geyser water contains practically no lime.

The three large hot springs at the top of the terrace are the JUPITER SPRINGS or the MAMMOTH HOT SPRINGS proper. There has been much discussion about the colorings of the various springs thruout the park, making it a most mysterious matter. There is absolutely no color in the water itself. The natural color of

clear water in large bodies is blue, and this may be due to the reflection of the sky or the refraction of light or both. At any rate it is a problem for the student of light. One thing you will notice, that where you find the beautiful green pools such as Emerald Pool, you will find the bottom and sides lined with yellow algae and all of us know that yellow and blue together make green.

Here in this small area (between JUPITER and ANGEL TERRACES) we find three of the rarer trees of the park growing; the limber pine, the red cedar and the Douglas fir. The principal tree of the park is the lodge-pole pine which you will see along the roads, except in the vicinity of Mammoth.

The small twisted trees with shaggy bark are the so called western red cedar, juniperus scopulorum, Notice the small, scale-like leaves standing opposite each other in pairs.

These trees with the long needles are limber pines. "Limber" because they are very flexible and you can tie their smaller twigs into knots. This is pinus flexilis of the white pine family and you are able to tell it from the lodge-pole pine by the needles. All of the white pines carry their needles in bundles of five, while the yellow pines, of which the lodge-pole is a member, carry theirs in bundles of two. This tree is seldom found above 7,000 feet.

This large tree is a Douglas fir, one of the finest trees in the park for size and real beauty. It is pseudotsuga taxifolia and

you can readily distinguish it by the extra three lobed scales on the cones. This low shrub growing about its base is the ground juniper or creeping juniper, juniperus communis sibirica. Notice the prickly, flat, pointed leaves, waxy white on the upper surface and set on the stem in threes.

ANGEL TERRACE: This is the Angel Terrace, so called because of the purity of the deposit and the resulting snowy whiteness of the terrace when inactive and the algae are not covering it.

BUNSEN PEAK, the mountain to your extreme left, was named for Robert W. Bunsen, a famous German physicist and the author of Bunsen's theory of geyser action, as well as many laboratory appliances that some of us know very well, such as the Bunsen burner. The mountain is composed of dacite porphery, a volcanic lava.

The mountain next in line to the right of Bunsen Peak is TERRACE MOUNTAIN which is capped with hot spring formation or travertine in a layer hundreds of feet thick, indicating that the formations are very old. On the top of this mountain are found rocks foreign to the vicinity, which were undoubtedly brought by a glacier during one of the three glacial invasions of the northern part of the park. This gives you some idea of the great age of the hot spring formations. Tomorrow when you go out by way of Norris, you will go thru a region known as the Hoodoos, a great chaos of ancient

Summary Proceedings: Schedule

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travertine rocks which have been broken and tumbled down from Terrace Mountain.

DEVIL'S KITCHEN is an old hot spring crater about 35 feet deep and possibly 75 feet long. It is interesting to go down into if you want to get some idea of the inside information on the hot springs. This will give you a good idea of the way in which the whole formation is probably honeycombed beneath us. Another interesting thing about the Kitchen is that it is the home of bats of a southern species very seldom found this far north, but here they live in this cave the whole year thru. You can hear them squeaking and if we are very fortunate one may fly out for us even in the day time.

We are now about four hundred feet above the Mammoth Hotel and have come nearly 1½ miles. This is the highest point we attain and there is, consequently, no more climbing.

This is called BATH LAKE and before the plunge at Mammoth Camp was built, was a favorite place for swimming. The deepest point under the diving board is eight or nine feet deep. (Experiment—put a paper funnel over the bubbles coming up thru the water and demonstrate the smothering action of the gas ($CO_2$) which will extinguish the flame of a lighted match.)

The warm, flat rocks around here are very attractive to snakes and

we often find them on our walks over the trail. The big ones most often seen are bull-snakes and are of the constrictor type. They attain a good size, averaging from six to eight feet in length in the adult snake, and they are not harmful. In fact they are beneficial in that they live on harmful rodents and insects and in a rattle snake country they even kill rattlers. It is against the law to kill snakes in the park and it would be a good thing if people everywhere were educated to know which are the beneficial and which the harmful snakes. There are no harmful ones in the park.

ORANGE SPRING was formerly called Orange Geyser, tho it is not a geyser at all but a hot spring which will probably soon cap itself off. By this I mean that the water will reach its own level, the opening will gradually become stopped up with its own deposit and the water will seek a new outlet. The result will be similar to Liberty Cap, an extinct cone we will see farther on. There are no geysers at Mammoth. The formation here is not strong enough to withstand the pressure. Three things are essential for a geyser according to the most generally accepted theory, Bunsen's, of geyser activity. Subterranean heat. A long strong tube or reasonably even fissure capable of withstanding great pressure. Water. Surface water seeping thru the cracks and fissures fills the tube gradually. The water at the bottom of the tube becomes heated to much above the boiling temperature at the surface because of the great pressure of the weight of the water above it in the tube.

Finally the boiling point of the water in the bottom of the tube is reached and the water starts to bubble and seethe. Some of it is splashed out at the top, thereby lessening the pressure (due to the weight) of the column of water and the remainder in the tube is shot out in the eruption of the geyser.

Just above CLEOPATRA TERRACE:- Here is a good shady place for a bit of history. The first administration building of the park was built on top of Capitol Hill in the form of a blockhouse. This was done as a means of protection, as the Indians were proving quite troublesome. In September 1877 a band of Nez Perce Indians came into Mammoth and killed a man, one of a party of tourists who had been frightened by the Indians in Hayden Valley and were leaving the park. This occurred at the little cabin which stood in Clematis Gulch and which was used as headquarters before the blockhouse was built.

Below us you see, to the right of Mammoth Hotel, what was for years an army post, Fort Yellowstone, with quarters for four troops of cavalry. Not until 1918 was this fort finally abandoned. The commanding officer of the post was also the superintendent of the park and his men were on all of the stations out in the park, doing the work you will find the rangers doing now. There was considerable dissatisfaction among the enlisted men at being called upon to do this sort of work when they had gone into the army to drill and to learn to become soldiers. So, finally,

the Department of the Interior took over the administration of the park and the soldiers were replaced by National Park Rangers. You will find the men in uniform stationed at each and every station, entrances included, in the park. It is up to them to see that you are given an opportunity to enjoy your trip thru the park, they will answer your questions to the best of their ability. They will find you if you get lost. Their duty is your service. Service to the public in the national parks is based on the policy of treating everybody in a kindly, friendly and courteous way, and if any members of the party have been treated discourteously or service has not been satisfactory, we would like to have a statement of his experiences which could be given the ranger in the Information Office or to the secretary of the Superintendent in the Administration Building, the square, gray building between the hotel and the white Weather Bureau building. Also the tourist is invited to write his criticisms to the Superintendent, Mr. Horace M. Albright.

The building in front of which you see the stack of horns and antlers is the Government Information Office and Museum and there you will find a ranger on duty from 7:30 a.m.,until 10:00 p.m., to show you thru the museum or to help you to choose your route out thru and beyond this park and into the others. There are ninteen national parks in all; one in Hawaii, one in Alaska, one off of the coast of Maine, and the rest all in the United States west of the Mississippi River. Of these Yellowstone is largest and oldest.

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The mountain to the west of us here is SEPULCHRE MOUNTAIN and is of early basaltic breccia, a volcanic lava. The name was given because of a very definite rock formation of that shape, the shape of a tomb, which is best seen against the sky line from Gardiner. To the north of us we see the northern end of the Absaroka Mountains, Absaroka meaning "home of the Crow". This is the very high range that bounds the park on the north and east. To the west are the Gallatin Mountains, of which the highest mountain inside of the park is a member, Electric Peak, 11,155 ft. To the south rises the most beautiful range of them all, the Teton Range, and some day we hope that it will become a part of the Yellowstone.

Very little indeed is known of the Yellowstone region before the advent of the white man. The red men whose legends take in all of the country around us have said little or nothing about the Yellowstone. As you know the Indian is most superstitious, and as there was little here that he wanted, with the exception of obsidian for his arrowheads, and as he preferred his purgatory after death rather than before, he stayed away from the land of the evil spirits that he believed this to be.

This is CLEOPATRA TERRACE, so called, perhaps, because it is so very changeable, one year here and the next gone entirely. When active it is one of the most effective of the terraces and photographs well because of the dark background of the hill and trees.

This little bush with the bright yellow flowers is quite a common one here and is known as shrubby cinquefoil, dasiphora fructicosa. It belongs to the same family as the rose. "Cinque foil" means five leaves and applies to the five leaflets in the compound leaf of the bush.

CAPITOL HILL is a very fine example of a terminal moraine, the dump heap left by a glacier. It was deposited on top of the travertine, showing, again, that the hot springs antedate the glaciers.

HYMEN TERRACE is named after the little god of marriage, Hymen, or more generally known as Cupid. Yonder is LIBERTY CAP of which I told you in connection with the capping off of Orange Spring, and the Devil's Thumb, a similar formation. They are cones of extinct hot springs, considerably harder than the formations around them which may have erroded away, leaving them standing there. However the surrounding formation is probably the more recent as it is more like the deposit being laid down at the present time.
The strata indicate that these were formed by springs which were at the cores of the cones of Liberty Cap and the Devil's Thumb.

This concludes the free guide trip for this morning. The Information Office and the Government Museum, as I have said before, will be open until 10:00 tonight. The exhibits there pertain chiefly to the natural history of the region. I shall be glad to walk down there with those of you who wish to visit it now.

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May 7, 1926...

This little book was [illegible] [illegible] [illegible]

ANCIENT GEYSER BASIN IN CROSS SECTION

Mr. J. E. Haynes, Acting Director,
Yellowstone Park Museum.

Approved by: May 30, 1926.

Superintendent H. M. Albright,
Dr. H. S. Conard, in charge of the ranger-naturalists.

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In the Firehole Canyon, where a new road is being built, there was discovered in 1925, by Ranger Parks of Madison Junction Ranger Station, a remarkable cross section of a geyser basin of prehistoric age. Even now, on frosty mornings, steam is seen issuing from crevices along the Firehole River at the base of the rhyolite lava cliff which rises 600 feet perpendicularly above the river. Unquestionably the top surface of this cliff was eroded many feet during the ages through which by slow erosion the river cut the great cross section seen today. The irregular areas on the side of the cliff were, no doubt, at one time chambers filled with hot water, but no one can tell whether the surface manifestations were quiescent hot springs, erupting geysers, a transition from one to the other, or a combination of both.

Before the cross section forming the present cliff was cut, obsidian sand and other surface materials were washed into the orifices of these chambers, finally filling them. Silicious cement has made a hard rock of this debris - a layered sand rock, totally different in both texture and origin from that of the cliff itself, yet so like it in color that it escaped discovery until fifty-three years after the Yellowstone National Park was established (1872).

Interesting indeed is the fact that this revelation is on the east wall of National Park Mountain, named to commemorate the birth of "The national park idea" in the then nearby camp of the Washburn Party in 1870. National Park Mountain marks the resting place, and actually reveals one of the pioneer geyser basins of Yellowstone National Park, which has today the most famous active thermal springs and geysers in the world.

The THREE SISTERS are rather unimportant pools. The object of greatest interest is the stump, which was not thrown in, but is what remains of a tree which grew there. From a vent near the stump, water is sometimes spouted to a height of four or five feet. The THREE SISTERS present a good view of how the algae vary with the temperature of the water. Near the stump where the water is the hottest, the algae are nearly white. As the water moves off in this direction (the crowd starts to follow the guide) it cools and the algae are much darker. You were told yesterday afternoon by the guide that the algae are closely related to the seaweeds and grow in Yellowstone National Park in waters of a temperature as high as 197 degrees fahrenheit. The trees on both sides of the road were killed by the hot water from the THREE SISTERS. The white material at the bases of the trees is silica that has been deposited as silicious sinter by the water drawn up by capillary action. That process will continue no longer, because there is nothing left to draw up the water. You know that in order to have trees petrify, it is necessary for water carrying mineral matter to replace the structure cell by cell. Usually petrified trees are fallen, but in the Lamar River valley, in the northeastern part of the park, petrified trees are found in their natural, upright positions; twelve layers of them in fact.

These flats are used, during the winter, as feeding grounds by the elk. With the approach of warm weather, the animals go to higher altitudes. There is no necessity, I believe, for me to enumerate the animals of the park. I might state that the only animals that it is permissible for the rangers to kill are the wolves, the coyotes and the mountain lions, and these only in restricted areas, designated by the superintendent of the park. To set at ease the minds of the ladies, I'll add that there are no rattlesnakes in the park, altho there are some harmless ones such as water and bull snakes.

The trees we are passing are lodgepole pines, identified by two needles in each cluster. In this portion of the park we have mostly lodgepole pines, with just a sprinkling of firs and of spruces. In other sections where other evergreens are found, as well as deciduous trees such as willow and aspen, some other species might predominate. The flowers are not to be picked, because we want the tourists who come after you to have the same opportunity of enjoying them as you have. They are (usually) lupine, yarrow, aster, Indian paint brush, compositae, and larkspur. (Some fringed gentians and monkey flowers later on in the trip --- point out flowers).

The park, as you were told by the lecturer last night, was made a National Park in 1872 by act of Congress, after considerable agitation by such public-spirited men as Washburn, Langford,

Doane and Hedges, to mention some. There are practically no Indian legends about the park. Some of the early trappers told some good yarns; Jim Bridger, for example, is accredited with this one:

He once located camp near a place that had the property of returning an echo after an interval of six hours. This he utilized as an alarm clock, calling out as he retired, "Time to get up". Six hours later he would be awakened by the sound.

Another one sometimes accredited to Bridger is this;- a portion of the park area was cursed by an Indian chieftain so that everything was petrified. The most astounding feature of the region was discovered after it had been noted that not only the trees and flowers, but also the birds, waterfalls and sunshine were petrified. One evening Bridger attempted, too late, to pull up his horse on the brink of a wide and deep chasm. The horse went right on over the chasm and continued on the other side as tho it hadn't been there. Bridger concluded from this that even the force of gravity was petrified.

(Following paragraph suggested by Superintendent Albright). Briefly the explanation of geyser action is this: the long, irregular geyser tube extending into the earth for a few hundred feet, becomes filled by melting snows and other surface waters. This water in the tube is heated by superheated steam rising from the uncooled mass of lava beneath. It is well known

that the pressure in water (being due to gravity) increases with the depth and that the boiling point rises with the increase in pressure. Finally, steam forming at the bottom of the tube causes the water to overflow at the surface sufficiently to lessen the pressure in the tube. Then there is a great flash of steam which expels the water producing the eruption.

The WHISTLE plays once or twice a season. Some visitors who were close by during the last eruption were surprised because, as they said, "We could hardly hear ourselves think". As a matter of fact the sound can be heard for half a mile. Visitors from the east often take this for the source of the popular drink. I am often asked, "Will the geyser play if one whistles in the right key?" To which I always answer, "Try and see!"

After we cross the ~~cre~~ k kindly stay on the walks. On the left is the CLIFF SPRING with a temperature of 196 degrees fahrenheit. It always boils as it is doing now, and is noteworthy because the hot water in it is so close to the cold water in IRON CREEK. It is possible to catch fish in the creek, swing them over into the pool and cook them without removing them from the hook. But Departmental regulations prohibit this inhumane practice. Otherwise I'd gladly demonstrate! On both sides of the walk you will see some of the best algous growth examples in this Upper Geyser Basin. The RAIN-BOW POOL, on the left, is more beautiful than SUNSET LAKE, on the

right. SUNSET, however, is hotter and larger. We seldom see any more of SUNSET than we are seeing today, because of the quantity of steam emitted. This is the famous HANDKERCHIEF POOL, 152 degrees fahrenheit. Contrary to the popular tradition, it does not cleanse the handkerchief. A handkerchief thrown in at the far side of the pool will be carried by the convection currents down into the crater, and after a few seconds, will be returned to the surface (I hope), where the bubbles are rising. Let's go this way. This is EMERALD POOL, and is considered the most beautiful green pool in the park. As a matter of fact the water is the same as the water in the blue pools but lower in temperature, the temperature being only 157 degrees fahrenheit. That gives the yellow algae a chance to grow, and the yellows showing thru the blue, produce the beautiful greenish effect. The logs you see were thrown in by visitors a few years ago and choked the pool. During the winter, the National Park Service succeeded in removing most of them. The logs have been carried below the surface by a deposit of silicious sinter from the water, while the continued deposit has acted as a cement to fasten the logs to the rock. Now it is practically impossible to pry them loose. These logs thrown into this beautiful pool by thotless persons years ago are examples of the type of vandalism which we so earnestly try to discourage. The park is yours, for your enjoyment and pleasure, and we urge you to be thotful of the millions of others who are coming after you and who also have the right to appreciate the lovliness and beauty of it and for whom it should be preserved.

The SPOUTER, 200 degrees fahrenheit, was so named because it boils this way all of the time. Of recent years it has developed a habit of draining, which it does now on the average of once a week. Quite suddenly the water drains out, leaving the bowl entirely dry. It remains so from thirty to sixty minutes, when it refills and boiling goes on as before.

The BLACK SAND POOL, 199 degrees fahrenheit, is so named from its location in the Black Sand Basin. It is one of the most beautiful of the blue pools; it is too hot to permit the growth of algae, and it is 40 feet in diameter. Beyond the BLACK SAND POOL is a region known as SPECIMEN LAKE, because from it have been taken numerous interesting specimens. The trees have been killed by the hot water and are encrusted with sinter, the same as those about which I spoke at the THREE SISTERS.

The black sand from which this basin is named, is a dark glass called obsidian. Obsidian is a hard, dark colored, vitreous rock which results when lava cools before crystallization sets in. Those of you who came from Mammoth, no doubt, saw OBSIDIAN CLIFF, twelve miles from Mammoth. You who came from West Yellowstone will see it later on. To return to the black sand. It is used in large quantities on our roads and makes a good road if watered frequently. 107 miles, constituting an important part of our main road system, are sprinkled twice daily.

Lecture. Landsdowne.

The PUNCHBOWL greatly resembles the TEAKETTLE you saw on the trip yesterday afternoon. The PUNCHBOWL is one degree hotter than the TEAKETTLE, being 202 degrees fahrenheit in temperature, more impressive, and more beautiful, due to the growth of the algae. Another difference is that while the TEAKETTLE drains after every eruption of the GIANTESS, the PUNCHBOWL never drains. It is said that in 1918, as a result of a certain constitutional amendment, the PUNCHBOWL did drain, however, and refilled with water, so that it never has been the popular stopping place it used to be, since.

The DAISY plays on a seventy minute to two hour interval. It gives a very attractive display, sending the water to a height of 30 to 70 feet for three minutes. The DAISY will play in ..... minutes, so we may as well wait for it, rest, and remove the stones from your shoes. Behind you, across the road, is an indicator for the DAISY, called BONITA POOL. About ten minutes after the DAISY plays the BONITA POOL starts to drain, and drains down to about 18 by 18 inches, slowly. Then it refills until it covers an area perhaps four feet square. Shortly after the BONITA attains its greatest extent the DAISY plays.

Another pool connected closely with the DAISY is seen beyond it, on the same side of the road. That, BRILLIANT POOL, 192 degrees fahrenheit, drains about a foot <u>during</u> the eruption. During the next interval it refills. Watch not only the Daisy, but also the Brilliant and after Daisy stops, notice how the water rushes back into the

crater without refilling it. The large cone in the distance is known as the WHITE PYRAMID and hasn't erupted for at least fifty-four years.

The RIVERSIDE GEYSER, named, of course, from its location, gives a beautiful display, as it plays to a height of 80 to 100 feet, arching the water in this direction so that it falls in to the river, the FIREHOLE. By some this geyser is called the musical geyser because it plays "Over the Waves". You must remember, however, that OLD FAITHFUL plays "'Neath the Silvery Moon". The RIVERSIDE plays about fifteen minutes at six to seven hour intervals. It is rather regular and will play next about ..... o'clock.

The SPA POOL, 30 feet in diameter and with an apparent depth of 15 feet, is named for the European medicinal springs at Spa, because this pool was supposed to possess medicinal qualities. Occasionally, it spouts for a few minutes to some 15 to 20 feet.

Within recent years (1922-23) the INDICATOR (sign removed) has been known to play to a height of one hundred feet for fifteen minutes. (Evidence of ex-temporary rangers Robertson and Alcorn). It has an irregular interval.

The GROTTO has the most unique cone of all of the geysers. The explanation offered for this is that the silicious sinter has been

deposited around the roots of an upturned tree. That theory cannot be proven without destroying the formation, and, naturally, that will never be done. You have seen on the trip enough overturned trees to enable you to see the similarity between the root system and this formation, I believe. The GROTTO plays much of the time, as its eruption is irregular in length, 15 minutes to 8 hours, and the interval is from two to eight hours. The structure can be seen to the best advantage when the geyser is not in action, and in missing the eruption not much is missed, as the water is never sent higher than 30 feet. The ROCKET, beside the GROTTO, plays at the same time to a height of 15 to 20 feet. Occasionally, two or three times a season, it plays alone to a height of 50 feet.

This group consists of the GIANT, with the prominent cone, the MASTIFF, to the left, and the BIJOU, still farther to the left. The BIJOU plays most of the time, from one cone or the other, sometimes from both, to a height of, as you see, about 15 feet. The MASTIFF seldom sends water more than 3 to 4 feet in the air. As the level of the water is almost that below the edge of the crater, the water doesn't even seem to go that high. Eruptions are irregular and infrequent. The GIANT is the geyser that sends a column of water to a height of 250 feet at the beginning of the eruption. It maintains that height for five to ten minutes, and then the column begins to lower, until, at the end of the eruption, the water ascends to but fifty feet. The eruption lasts for from an hour to an hour and a half. The reason that I don't go closer is this. Recently (1923)

water has been shot from several minor openings around the cone, even from the hole in which the sign-post is placed. This happens without warning, to a height of eight feet for some. Consequently, I don't want to run any risk of having you scalded. The cone, as you already have noticed, is an irregular one. Despite rumors to the contrary, the cone has been that way during the more than a half-century that the Giant has been known. Whether it was formed that way or whether a portion was blown away by an exceptionally violent eruption is, therefore, impossible to say. The interval for the GIANT is six to fourteen days. The last eruption was recorded on the ...., so we don't look for one again until .....

The OBLONG, 43 feet by 20 feet and sounded to a depth of 36 feet, formerly played to a height varying from 20 to 40 feet for seven minutes, two or three times a day. In recent years eruptions have been less frequent. It isn't a great loss, because the peculiar shape of the crater, from which the geyser gets its name, and the beautiful rock formation inside and around the crater have always attracted more attention than has the eruption.

The MOTORBOAT is unusual. You can locate it about fifteen feet off shore by the white bubbles ascending. By listening carefully, you will be able to catch the faint put-put sound from which this gets its name. Visitors tell me that it sounds like a motor boat missing on one cylinder.

Contents.

Lecture. Landsdowne.

The INKWELL is so named because it presents the two colors, red and black. The red is due to algae, the black to a peculiar deposit of sulphides. The water is 200 degrees fahrenheit.

The algae in the ALGOUS TERRACES, on the left, are growing in water flowing from the CHROMATIC POOL which you will see next. While the ALGOUS TERRACES do not present the degree on shading presented in the vicinity of HANDKERCHIEF POOL, many visitors look upon the depth of color as a compensation.

The CHROMATIC POOL is so named because of the delicate shadings of x color. The musical members of the party will provide any further explanation. The CHROMATIC, like this

BEAUTY POOL, is blue during the summer but more of a green during the winter. The reason being that the cold weather cools the water sufficiently to permit the yellows and oranges of the algae to become more luxuriant. As at EMERALD POOL, the yellow, showing thru the blue produces a greenish effect. Altho the cold weather affects the pools, remember that it has no effect upon the action of the geysers.

WAVE SPRING looks as tho a succession of pebbles were being dropped into it. The water flows from one pool to the other. (which way?) The waves are, no doubt, due to some peculiarity in the tube.

The ECONOMIC GEYSER was so named because practically all of the water expelled ran back into the crater. The only water lost was a small quantity blown away in the steam. The geyser played frequently to a height of 20 feet. The man who named it did better than he thought, as the ECONOMIC hasn't been observed to play, recently, except at rare intervals.

This group consists of the BURNING POOL, the large opening, the GRAND GEYSER, the opening to the far side of the BURNING POOL, and the TURBAN GEYSER, the small opening on this side, close to the crest of the pool. The TURBAN and the GRAND play together, and present an interesting comparison. While the TURBAN plays to a height of 15 to 20 feet, 40 feet at its best, the GRAND plays 150 to 200 feet. The TURBAN plays continuously, while the GRAND plays in a series of spurts, varying, usually, from fifteen seconds to a few minutes in duration, and in number from six to sixteen. The length of the eruption depends upon the number of spurts, usually from fifteen to thirty minutes. The TURBAN plays thruout the GRAND'S eruption, and for fifteen to twenty minutes after the GRAND stops. The GRAND plays at intervals of from ten to twelve hours, and is, in my opinion, the most beautiful of all of the geysers. The BURNING POOL, 199 degrees fahrenheit, is alternately calm and boiling. The man who named it must have seen it in the latter phase, because he explained the name by saying that the bubbles of steam coming to the surface resembled blue and yellow flames. The blue flames aren't hard to see, but I must

confess my imagination has never been equal to the task of seeing the yellow. The BURNING POOL like the TURBAN is connected with the GRAND. The eruption of the GRAND causes the BURNING POOL to drain quite dry. It remains dry for thirty to sixty minutes, then refills rapidly to two thirds its capacity, filling to the brim more slowly. (Skinner) I have seen it refill within ten minutes of the end of the eruption. (Lansdowne) Then the alternating periods of calm and boiling go on as before.

These TRIPLETS were at one time considered to be the indicators for the GRAND, but that theory was exploded. They frequently display varying degrees of fullness; for instance, the one on the end may be empty, the one in the middle half full, and the other one quite full.

The SPASMODIC plays from twenty to sixty minutes to a height of from two to four feet, and one to four times a day. It's chief interest is due to the fact that it possesses four openings. Sometimes it plays from one, at others from two, three, or all.

The SAWMILL plays more or less all of the time, as it plays from five to eight times a day, and each eruption lasts from two to three hours. The water spurts from twenty to thirty feet in height, with occasional spurts to fifty. Due to some peculiarity in the tube, the water is expelled by a circular motion, resembling, to the mind of the man who gave the name, a sawmill in action. The

picture of the geyser eggs in the Haynes Guide was taken here; geyser eggs are geyserite built up from a small nucleus by the action of the water. They are not planted to hatch new geysers.

Beyond the SAWMILL is the LIBERY POOL, dry 90% of the time. Infrequently it fills, and even plays to a height of fifteen feet.

The WITCHES CAULDRON, 201 degrees fahrenheit, the CHURN, and the BULGER, 199 degrees fahrenheit, are not of any importance. The interest attached to them is due to the proximity of their hot water to the cold water of the FIREHOLE RIVER.

To your left, as you approach the bridge, don't miss the CHIMNEY. It is appropriately named, isn't it?

RETURN TO HOTEL

Time can be filled in along the way by:

1- Number of visitors for prededing year.

2- Discussion of the merits of the various entrances.

3- How the park received its name.

*****

This lecture was written by ex-temporary ranger J.C.Lansdowne and approved by the following men:

Superintendent H. M. Albright.
Dr. H.S.Conard, in charge of ranger naturalists.
Mr. J.E.Haynes, acting director of the museum.

April 22, 1926.

AFTERNOON LECTURE AT OLD FAITHFUL FORMATIONS * GIVEN DURING 1922-23.

Temporary Ranger James D. Landsdowne.

Revised to date and approved by: May 20th, 1926.

Superintendent Horace M. Albright,
Dr. H. S. Conard, in charge of the ranger-naturalists,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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Guide trip from the hotel, - to be reversed if starting from the camp.
1½ miles - 1 hour.

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The brown building to the right is the Haynes picture shop. Whether you desire to buy or not, I advise you to stop in and look around. You will be well repaid. Before us is the Hamilton store which sells almost everything from soft drinks to souvenirs.

The steam up on the hillside is coming from SOLITAIRE, a lone hot spring which boils continuously. From it water is piped for the Geyser Baths which we will see presently.

This is well named the CASTLE GEYSER. Its cone stands 27 feet high. It sends water 30-50 feet into the air for half of an hour when it erupts. Its habit is to play three or four days in succession, then rest for four to seven days. "Several times each season it has eruptions of an unusual character in which columns of water are thrown to twice their usual height". (Haynes Guide)

As this is your first meeting with a geyser, I might outline the theory of geyser action. Geysers are found in but few places; Iceland and New Zealand have some. The Yellowstone is the greatest geyser region in the

world, and this Upper Geyser Basin is the greatest in the park.

There are three requisites for geysers; heat, water and an irregular tube in hard rock. This is an old volcano region; and deep down the lava is still hot. Thus we have one of the three, heat. The second, water, is supplied by the abundant rains and snows. The third, hard rock, is this silicious sinter or geyserite.

When the water from the melting snows seeps toward the interior of the earth and encounters the heated gases and vapors rising from the hot lava, its temperature is raised until some turns to steam, and that supplies the force to throw out the rest of the water. In some way cavities or wells, and tubes have been formed in the hard lava. The increased pressure as we go toward the center of the earth requires higher temperatures to boil water, i.e. change it to steam; obviously, therefore, the nearer the water is to the surface, the lower the temperature required for boiling. Now imagine a column of water (using arm as an illustration). The lower the water, the hotter the rock, so a bit of water at the bottom of the column is changed to steam. In its attempt to escape, it raises the whole column. That raises the water to a point where less pressure is exerted against it, so less heat is required for conversion into steam. Suddenly a large amount flashes into steam which forces out, in an eruption, the water above it. That is, roughly, the way in which geysers work.

This colored material on the geyserite, is not iron but a plant

growth known as algae. I ask you not to step on it because stepping on it kills it and we want the visitors later in the season to see it too. You can see where it has been trampled; let us hope by visitors who didn't realize the damage they were doing. The algae are hot water growths and vary in hue with the temperature; the hotter the water, the lighter the algae. So it ranges from colorless to brown, thru yellow, orange, red and green and is an indicator for the temperature of the water.

This CRESTED POOL or castle well is about 195 degrees Fahrenheit so you see no algae. The best view is from the CASTLE side. You get an idea of the clarity of the water when I tell you that you can see down about forty feet. I am frequently asked whether geyser water is fit to drink. Government chemists say there is nothing in the water which would make it unfit for drinking but advise against it because it contains so much mineral matter in solution. It contains silica, iron, arsenic, chlorine, calcium and many other substances; in small quantities of course. The water of the river yonder THE FIREHOLE, is drinkable but is not palatable, being warm due to the number of geysers and hot springs along its banks and emptying into it. Water for the purpose of drinking in this region is piped long distances, the hotel and the camp each having their seperate sources.

( If the SAWMILL is playing, point it out before starting down the hill. Usually there are some flowers in bloom at the small bridge. Point them out, name them, and caution visitors against picking them).

This FIREHOLE RIVER was first called BURNT HOLE by the Indians because

of a forest fire at one time. It joins the GIBBON to form the MADISON, which, in turn, joins the JEFFERSON and GALLATIN at Three Forks, Montana, to form the MISSOURI. The fishes are chiefly trout, and no license is required for fishing within the boundaries of the park. The day's limit is ten fish, of a minimum length of eight inches.

This is the Lion family; the one with the prominent cone is the LION, this opening is the LIONESS, the LARGE CUB is there, and the SMALL CUB here (point out). The LARGE CUB and the LIONESS have not been observed to play for a number of years. The SMALL CUB plays to a height of 3-6 feet, for fiteen minutes every hour or two. It starts without warning, so don't get too close. The LION plays to a height of 60 feet several times a day. The LION can be seen from the veranda of the hotel, and no doubt you will see an eruption of the LION during your stay in the vicinity.

These names, IRON and ARSENIC POOLS, signify nothing. Iron and arsenic are found, as I told you, in some of the park waters, in small quantities. The coloring is not due to iron but to algae, as I explained at the CASTLE.

(Somewhere along the trip OLD FAITHFUL will erupt, so tell about it when it happens. If the start of the trip is made from the Camp, stop at OLD FAITHFUL on the way to the CHINAMAN).

OLD FAITHFUL was named by the Washburn-Doane Expedition in 1870, because of its dependability. As a matter of fact, its interval <u>does</u> vary. Although, usually, it can be depended upon for an eruption every sixty-two

minutes, it is sometimes sixty and sometimes eighty. The water mounts 125 to 170 feet in the air and the eruption lasts four minutes. A very pretty effect is obtained when the hotel plays its searchlight upon it. This is done the first eruption after dark. The best effect is obtained from the side opposite the light.

Across the road from OLD FAITHFUL is located the ranger station. Stop in for any information; there's a ranger in charge until late in the evening.

This is well named the BAR. It does not erupt, but (pointing out) the little fellow at the side spouts all of the time. The rangers have named it the Earring. This was once known as the DEVIL'S BAR, and you'll find it so marked on the old maps. It is said that the trappers used to come here to talk to his Satanic Majesty below. Once, during a particularly bad winter, they so annoyed him that he could get no rest. Therefore, he fashioned a flap and buttoned it across so he could have some quiet. The Earring marks where the fastening was.

ALGOUS POOL is so named for the quantity of algae present. The color is deep, showing that the water is cool. That means, however, comparatively. Don't stick your fingers in it.

This BEACH SPRING is one of the most beautiful I can show you. The rock, geyserite, has been deposited in a ledge. The algous growth makes it look much like a beach, doesn't it? By comparing the shades you will readily see that the water is hotter at one side of the pool

and also that the water here is much hotter than that in the pool we have just left.

( I can't recall the name of this, located right beside the BEACH SPRING and near the DOUBLET POOL). This ..... plays about fifteen feet high a few times a season, (LANDSDOWNE) for about three minutes. It is chiefly of interest because it has two vents, one in the center, the other here at the side. Sometimes it plays from one, sometimes from the other (Skinner).

Be very careful here and stay away from the DOUBLET POOL. The reason is that the water extends some distance back from the edges under the surface and should one fall in he would be very badly scalded. The ledge has been built up very slowly as the deposit is but a small fraction of an inch yearly.

The SPONGE is quite aptly named. Here, by the way, is one place where the coloring in the geyserite is due to iron (Skinner). The SPONGE plays every three minutes for about 15 seconds, to a height, as you see, of four feet. It isn't very big, but it works all of the time, so we're proud of it as every visitor sees it in action. Notice how the bowl fills and drains.

The PUMP is named for the sound it makes. It goes all of the time.

The TOPAZ is one of the hottest bodies of water in the Upper Basin. Its temperature, taken recently by men sent from Washington, was found

to be 202.64 Fahrenheit, which places it slightly below the TORTOISE SHELL with a temperature of 203 Fahrenheit.

Be very careful here. I don't want to alarm you unduly, but the GIANTESS plays without warning, and, while I expect no eruption, one can never be too sure, and I want no one to be exposed to that mass of scalding water which is thrown out in all directions. That is why we have put up the "Dangerous" sign. A lady asked me last Thursday, "What is that thing?" I said, "The GIANTESS". "Then why," she asked, "is it marked 'dang-ger-roos'?" We have here, as well as the GIANTESS, the TEAKETTLE and the VAULT. Let us consider the VAULT first. It is about thirteen feet deep and is always the quiet pool you see, except after an eruption of the GIANTESS, which drains the VAULT. It refills about a day and a half after the eruption. That shows its connection with the GIANTESS. How different the TEAKETTLE! It boils that way all of the time. But it also drains after the GIANTESS erupts, and refills after the same interval as the VAULT. Then, instead of remaining quiet like the VAULT, it goes on boiling. The GIANTESS plays irregularly, to a height of 100 to 200 feet for twelve to thirty-six hours. The guide-book gives an interval of ten to twenty days. It makes so much fuss that an eruption cannot go unnoticed, as in the case of the CASTLE or GIANT which may erupt during the night without anyone being the wiser.

Before you, on the far side of the FIREHOLE RIVER, is the Old Faithful Geyser Baths establishment, which I mentioned as being supplied by water from the SOLITAIRE upon the hill. The water in the baths is warm and,

unlike some of the water in this vicinity, very soft, forming a suds readily.

(A small opening on the hill between the GIANTESS and the BEEHIVE, not named in 1923. This little fellow plays every twenty minutes to a height of ten feet for one or two minutes. It started in 1922. So far it has remained without a name."

The BEEHIVE is noted for giving a fine eruption. The water is ejected in a column to a height of 200 feet. The eruption lasts from six to eight minutes. This geyser erupts only after an eruption of the GIANTESS, altho the GIANTESS does play without being followed by the BEEHIVE.

(Cross the river to the CHINAMAN). Across the river you see the CASCADE GEYSER and the SPUTTERER, both rather unimportant. This pool is known ad the CHINAMAN. It never plays, altho it used to. It was named for the Oriental who once conducted a laundry on the spot. You see it must have been very handy; hot water in the pool, and cool water in the river. Unfortunately, he dropped something into the pool one day and an eruption occurred, so the story goes, taking the Chinaman and his laundry high into the air. By a strange quirk of fate, he dropped back into the hole and has never since been seen. So this has been named the CHINAMAN in his memory. Some say he went all of the way thru to China, but I can't vouch for that.

This is the end of our trip. (Direct tourists to Old Faithful, the Geyser Baths, Hamilton's, the Haynes Shop and the Inn.)

(Signed - - James D. Landsdowne.)

EVENING LECTURE AT OLD FAITHFUL CAMP * Given during 1922 and 1923.

Temporary Ranger James D. Landsdowne.

Revised to date and approved by: May 20, 1926.

Superintendent Horace M. Albright,
Dr. H. S. Conard, in charge of ranger-naturalists,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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Many questions are asked me concerning the Indian legends of the Park. As a matter of fact, the Indians had no legends about this region, and were ignorant of it in a large degree. As late as 1877, when the Nez Perces were pursued across the park, they had to impress the services of white guides.

Living within the area of what is now the park were the Sheepeaters, who got their name because they lived at high altitudes and ate the mountain sheep. They probably took refuge here from their more warlike neighbors, as they were small in stature. Furthermore, they were undeveloped mentally, so nothing is learned about the region from them. To the southeast, southwest and south of the park lived the Shoshones, to which family belonged the Sheepeaters; on the northwest were the Blackfeet, and on the northeast were the Crows. These Indians made incursions to obtain obsidian for arrowheads and spear points, but were, no doubt, afraid to approach closely to the phenomena. Other causes may be assigned for the Indians' lack of knowledge of this vicinity. The park is almost surrounded by high mountains; the timber is dense, and in the valleys around the game was more plentiful. So convenience, undoubtedly, had much to do with the Indians staying away.

The first information of the park emanating from white sources came from John Colter, who accompanied the Lewis and Clark expedition of 1805 to the coast, but left it on the return to hunt and trap in this region. He did not return to civilization for five years, and when he did arrive in St. Louis in 1811, the region he described was derisively referred to as "Colter's Hell".

Further information was obtained from another trapper, James Bridger, in the employ of one of the trading companies. Bridger had a well established reputation of being a prodigious liar, so it's no wonder that his stories received no more than a hearing and a laugh. He tried editor after editor in his attempts to have his information printed, but was always laughed out of the office. In fairness to Bridger, I must add that later one of the editors offered him a public apology.

Bridger told several well-known yarns. For instance:

A. He obtained a fine drink of water at the top of a mountain. After he had ridden to the base, he was in need of a cool, refreshing drink, so searched for the water flowing down from the spring on top. He found it, but discovered, to his dismay, that the water was boiling hot. That was caused, he explained, by the friction encountered by the water while flowing down the mountainside.

B. While hunting one day, he spied a fine elk. He took aim and shot at the animal, with no effect. He was a good shot, so when a second shot also failed, Bridger became angry, clubbed his rifle, and ran toward the elk. He was brought up short by a good bump on the forehead. Examination brought out the fact that he had run into a mountain of glass Obsidian Cliff. When he felt his way around the mountain, he saw the elk at a distance of three or four miles, so not only was the mountain of glass but also it magnified, like a telescope.

Is it any wonder he had difficulty in making people believe such tales?

Joseph Meek was in the vicinity about the same time (1829-30) but added little information.

In 1834, Warren Angus Ferris, a clerk in one of the fur companies, wrote an article describing what he had seen here and had it printed in a Buffalo (N.Y.) paper. It was copied by a Mormon paper in Illinois and later became well known, tho the name of the author was lost until 1900 when it was recovered thru the efforts of the late Mr. Olin D. Wheeler of St. Paul.

Attention to the Mormon migration, the waning of the fur business, and the search for gold seem to have taken attention away from the park area. In 1859 a detachment of soldiers was ordered to take a look at this locality. As the officer in charge was to observe an eclipse of the sun from some point north of the Canadian boundary, he had no time to waste, so, when he encountered heavy snows, continued toward Canada.

Then the Civil War attracted attention, so nothing was done about exploring this wonderful region until 1869, except that a goldseeker, named De Lacy, passed thru in 1863. The park has a creek which bears his name.

In 1869, several important people of Montana organized an expedition to test the truth of the stories they had heard. An Indian scare cause all of the party, except three men: Cook, Folsom and Peterson, to withdraw. These three returned with such stories that the Washburn-Doane expedition

was organized.

Washburn was surveyor-general of Montana, Doane was the lieutenant in charge of the military escort. In the party were prominent men: Langford, Everts, and Hedges, to name some. That expedition of 1870 visited practically everything of interest on the present loop road system except Mammoth Hot Springs. In this section, it might be of interest to know that the Beehive, the Castle, and Old Faithful geysers were named by the Washburn-Doane party. It was, as a result of the efforts of these men; writing, lecturing, and lobbying at Washington, that this area was set aside, "For the benefit and enjoyment of the people" by an act of Congress, signed by President Grant on March 1, 1872.

The Hayden party remains to be mentioned. It was under Dr. Hayden, head of the United States Geological Survey. It consisted of scientists, and accurate observations were made; the height to which the geysers played, their intervals, etc.

I am frequently asked how the park got its name. It was named for the river which got its name many years ago. At first the Indians called it "Mi tsi a da zi" which means Rock Yellow River. The French trappers and traders who next came in called it the Pierre Jaune or Roche Jaune, Yellow Stone or Yellow Rock, and established English usage has finally written it Yellowstone.

In conclusion, let me call your attention to our eighteen other national parks, each of which is distinctive. You will find in them objects of

interest you will not find here, just as here you find things to be found in no other. All the national parks are in the charge of the National Park Service, a bureau of the Department of the Interior. The rangers are to protect the parks for the enjoyment of all, and to be of service to visitors. This talk is one evidence of the latter.

(Signed) James D. Landsdowne

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT ** SHORT TALK

Season 1925 Dr. H. S. Conard

Revised to date and approved by: May 30, 1926.

Superintendent H. M. Albright,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum,
Mr. E. J. Sawyer, Park Naturalist.

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It is my pleasure and privilege to welcome you in behalf of the National Park Service, and to do all that I can to help you to do what you want to do and to see what you want to see while you are here. There are so many things to do and see about Camp Roosevelt that I will run over some of them now. You can then plan your stay to the best advantage.

In the first place this is the place where the volcanic origin of the park can most clearly be seen. Right back of us is one of the big volcanois that did it. Prospect Mountain, directly back of the camp, 3500 feet high, is a part of the rim of the crater. This was a huge crater, fifteen miles across. From Prospect Peak the ring of the crater can be seen even better than from Mt. Washburn. Standing on Prospect, we see Mt. Washburn, 10,317 feet, then Dunraven Peak, Hedges Peak, Observation, Cook and Folsom, making a great amphitheatre; the old crater. The rim is broken down at the northeast corner and Tower Creek flows out, draining the crater. The last lava flows from this crater form the basaltic columns on both sides of the lower canyon at Overhanging Cliff just below Tower Fall. On the walls of the canyon you see other flows of basalt, forming layers of columns. And between these the layers of volcanic gravel

thrown out by explosive eruptions of the old volcano. Of the six hundred feet of canyon wall, you saw that only a small portion was made of lava flows. The most of the height is volcanic gravels or breccias.

When these gravels were being deposited from time to time, ample forests grew on the slopes of the volcano. Frequently such a forest was buried in gravel and boiling mud, and this has given our petrified trees, which are so abundant in this region. THE petrified tree, the one on the post cards, is just two miles west of us, near the main road. It is fenced around to keep a certain class of tourist from carrying it away piecemeal. One very fine specimen that once stood on that same hillside has already been carried away. It is plain, therefore, that unless folks can remember that there are hundreds of thousands of visitors to follow them, there will soon be no Yellowstone Park to visit. We ask your cooperation in the protection and preservation of all of the strange and beautiful things of the park. You see the reason.

Seven miles east, along the trail, is the famous petrified forest of Specimen Ridge. Here the most casual visitor sees from eight to twelve layers of petrified trees, one above the other. You see at the top of the hill a huge petrified Sequoia stump, almost identical with the coast redwood of today. On the cliff you see that the layers of the rock are horizontal, - layers of volcanic gravel. Fifty feet below, on a lower level, stand two petrified pines, twelve feet tall and two or three feet in diameter. All of these show the petrified roots in the petrified soil just as they grew five million years ago. What has happened? Obviously the lowest layer of trees grew first. Then came an eruption of

this volcano behind us and buried the forest in hot mud and gravel. Later another forest grew on the ruins of the first. Then this was buried by an eruption. And so on for as many layers as you can count. Then they were cooked in geyser water for a million years or so, until every molecule was replaced molecule by molecule with silica - sand - quartz. The washing out of the river valley exposed the trunks that we now see. How many trunks lie buried in the mountain no one can tell. Doubtless Dr. Thone is right when he says that these hills are as full of petrified trees as a cake is of raisins.

This Specimen Ridge country can only be reached with a guide. It is done by horseback, leaving camp at eight-thirty in the morning and returning at three, in time for the bus to Mammoth. The trip takes us down the Cooke City road, across the Yellowstone River, up the steep hill past a huge glacial boulder to the brink of the lower canyon. We ride along the brink perfectly safely where you can look right down from horseback to the river, 600 feet below. There we see a group of boiling springs, where we sometimes cook our own dinners on nature's own stove. Thence we go on past the Overhanging Cliff, seeing the wonderful face of the cliff with its basaltic columns; then up another steep hill and out to a point where Tower Falls is seen in face view, a silent wisp of spray a mile away across the valley. On the next plateau we always find a herd of antelopes, many elk horns and occasionally a coyote. We have lunch in a little aspen grove by a stream of delicious water. After lunch we go on to the top of Specimen Ridge, from which we see the whole Lamar Valley stretched out 1500 feet below us, and a glorious horizon of mountain

peaks all around; thence down to the petrified trees. We come home along the floor of the valley. The descent to the valley is one of the most gloriously scenic rides you can find anywhere in the world. In fact this whole trip is easily one of the most interesting, instructive, thrilling and scenic experiences you can get in the park. If you have only one day, do this.

After the volcanoes and petrified trees there was a long period of relative quiet. And then came the glacial period. A great glacier swept in from the Absarokas on the east, covered this region three thousand feet or more with ice, and slid on to Mammoth. The big rocks that you see on the hills in front of us, and in our yard here were left by the glacier. They are of granite. There is no granite east of us for more than five miles. These probably came twenty miles or more. Another glacier swept into the park from the west and the two streams met at Mammoth. There they met and flowed northward thru the canyons of the Gardiner and Yellowstone rivers out toward Livingston. They left a huge hill of gravel at Mammoth known as Capitol Hill. Strange to say this hill rests on hot springs deposit. And what does this mean? It means that the hot springs had been in eruption a long time before the glaciers came, that they had already built up a huge amount of deposit, and that the glacier rode over the hot springs and never put them out. They seem to be running just about the same as ever.

How long ago was it? Well, the Scandinavian geologist DeGreer has calculated very accurately that it is about 12,500 years since the

last ice sheet melted off of the latitude of Christiania. And American geologists think that the Grand Canyon of the Yellowstone has been cut in post glacial times and in about 12,000 years. Iowa geologists consider - and I have examined some of their evidence and am inclined to accept their conclusions - Iowa geologists estimate the whole glacial period in Iowa as about 800,000 years. So it may fairly safely be said that the Mammoth Hot Springs are about a million years old. And the petrified trees about five million. The volcano was active during the Miocene Age of geologists. It may have been active off and on for a few million years. All of this, and many more things you can read - a child can read - in the hills of Camp Roosevelt.

Leaving geology, this is the best place in the park to see birds. Some folks say there are not many birds in the park at best. It is true that coniferous or evergreen forests harbor fewer birds than deciduous forests. But at daybreak in this region, especially in the early part of the season, there is a fine chorus of bird songs. The robin, western bluebird, pinksided junco and mountain chickadee are abundant. The redshafted flicker - red beneath where the eastern one is yellow, and a very handsome fellow - is common. Crows, ravens, red tailed hawks, and camp robbers are the larger birds. In a lake beyond Junction Butte yonder, seen on the way home from Specimen Ridge, is a colony of yellow-headed blackbirds, the only colony in the park. At every water fall there is an ousel nest. This little bird walks under water where it is so swift that you or I couldn't possibly stand. It has been made famous by the writings of John Muir. Many other birds live about here.

And this is headquarters for seeing the wild animals of the park. Twelve miles up the Cooke City road is the Buffalo Ranch. But you cannot see any buffaloes there. The Lamar herd of about 300 is out in the mountains eastward, out of harm's way. It is best so. They are dangerous animals. You can see a dozen or so in a sagebrush corral at Mammoth, with all of the benefits of a strong fence between them and you. That is the only place to see the buffaloes. The next biggest animal is the moose. We occasionally see one or two on the trips to the beaver dams in the evening. There are many elk in this region, but at this season they are up in the mountains over 8,000 feet. If you are well seasoned in mountain climbing we can climb Prospect Mountain and take a chance of seeing elk. Sometimes we see as many as fifty and sometimes none.

Mountain sheep spend their summers above 9,000 feet. So the place for them is on Mt. Washburn. If you didn't see any on the way over, you have missed your chance. Deer are frequent, but they wander about alone, or a mother with a fawn or two, and we never know where to find them. Out on the hill in front of us, and on over toward Garnet Mountain is the antelope pasture. Out there we nearly always find a herd of antelopes. We can go over to them in the morning if you like. The bears are abundant all around the building and at the kitchen door. They are tame, but do not take any liberties with them. It is wise not to feed them from the hand. Accidents happen every day to tourists who take undue liberties. We feel that the accidents are due to carelessness on the part of the people, and the bears are practically never to blame. Even a tame bear is a wild animal. Act accordingly.

Now if I have omitted just the thing you wanted to have me tell you about, please ask questions. Buttonhole me anywhere and at any time. Ranger service is always free, and we want to be of use to you. At ten minutes to seven I will be back here to go with any who want to go to the beaver dams to see the beavers swim about. The place is about two miles away, and along the auto road. We go over and sit on the bank quietly and watch. So far the beavers have never failed to put on a show every evening. It is different every time. We never know what they will do, but they will do something. We get back from this about nine to nine thirty. Tomorrow morning at 8:30 I will be here to go on a hike with anyone who will go with me; and we will go wherever you want to go. It is all interesting to me. We can go out to the antelope pasture and down to the old Yancey Ranch to see the conies, or over the hill to Lost Creek and Lost Lake for flowers and trees and beaver dams, or into the lower canyon to see the hot springs and on to Overhanging Cliff to see the lava flow and back over the scout trail through the flower gardens, or to Junction Butte, or anywhere else. See you at six fifty.

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT ** LONGER TALK

Season 1925. Dr. H. S. Conard.

Revised to date and approved by: May 30, 1926.

Superintendent H. M. Albright,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum,
Mr. E. J. Sawyer, Park Naturalist.

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It is my pleasure and priviledge to welcome you in behalf of the Department of the Interior and to do all that I can to help you to do what you want to do and see what you want to see while you are here. There are so many things to do and to see while you are here at Camp Roosevelt that I will run over some of them now. You can then plan your stay to the best advantage.

By all odds the most interesting, instructive and thrilling experience here is the horseback trip over Specimen Ridge. This starts in front of this building at 8:30 in the morning, returning by three in the afternoon, in time for the bus to Mammoth. The whole distance is about 14 miles; the horses are safe, and anyone can go. We go out along the Cooke City road, across the Yellowstone River up a steep hill past a huge glacial boulder, to the brink of the lower canyon. We ride along the brink where you can look right down from horseback to the river 600 feet below. You don't have to ride that close if you don't like it. There is all outdoors on the other side. We see a group of boilding springs and steam holes beside the river, where we sometimes go to cook our dinner on nature's own stove. Thence we go on past the overhanging cliff, seeing the wonderful face of the cliff with its basaltic columns. This takes us right along the top of the row of columns you saw across the river just this side of Tower

Fall. Then we go on up another steep hill and out along the canyon where we get a front view of Tower Fall, a silent wisp of spray a mile away across the valley.

On the next plateau we always find a herd of antelopes, many elk horns, and occasionally a coyote. We follow the antelopes as long as we have time, and then stop for lunch in a little aspen grove beside a stream of delicious water. After lunch we go to the top of Specimen Ridge, from which we see the whole Lamar Valley stretched out 1500 feet below us, and a glorious horizon of mountain peaks all around. On the way up we see pieces of petrified wood. We go down over the brow of the hill a couple of hundred feet and dismount for the famous petrified forest. Here we pass along a narrow path beside a stump of petrified sycamore, and out on the side of a very high, steep slope, dotted with standing trunks of petrified trees. The first is a huge stump of Sequoia, almost identical with the coast redwood. This stump is six feet in diameter and eight feet tall. When you go below it you will find the petrified roots in the petrified soil, just as it grew 5 million years ago. Fifty feet below this stand two magnificent trunks of petrified pine, also on their own roots. If you will walk down the hill the most inexperienced person will find eleven or twelve successive layers of fossilized forests. We look at the hillside and see the rock strata-the soils on which trees grew - lie horizontally. They grew on approximately level ground, and we are looking at a whole series of forests, that grew in succession, the upper ones on the ruins of the lower. The rock between is volcanic gravel and mud. A moment's thought shows any-

one that what happened is this: the big volcano just behind us had forests growing on its flanks, just as is the case with modern volcanoes. Then came an eruption and buried the forest in a bed of gravel and mud. Things were quiet then for a long time, at least in that region, and another forest grew up. This then was buried. And so on for a dozen layers. Then they were all cooked in geyser water for a million years or more, until all the wood was gradually dissolved out and replaced molecule by molecule with silica - stone. Then the hillside was washed out by the river and the trees were exposed to view for us to see. The preservation of the wood is often very perfect. You can easily count the ages of the trees by the rings in the wood, just as in modern trees.

From the Petrified Forest we ride down the hill with the most glorious mountains and valleys below us, a thrilling scenic ride, past more petrified trees, past Crystal Creek where we get another cold drink, and down into the Lamar Valley. Here we often see more antelopes. Coming past Bird Lake, we see the yellowheaded blackbird, one of the two colonies of this handsome bird in the park. Those of you who live in Wisconsin or from there to Utah know this species already. Returning north of Junction Butte, we usually stop at Icy Spring, the coldest water that comes out of the ground. Thus on the trip we see more geology, more wild animals, more flowers, and more sublime scenery than on any other trip in the Yellowstone Park and some say, in the world. It is our best offering. A wrangler always goes on the trip as guide. On occasion a ranger naturalist goes too.

If you do not care for so strenuous a trip tomorrow, there are several fine hikes on which I would like to have some playmates. If you want to see some antelopes, we will go out to the grassy hill in the front of us and work along toward Garnet Mountain until we meet them. We rarely fail to find a bunch. They are easily the most dainty and beautiful of the wild animals of the park. The little ones of this years crop are simply charming. We can go on over to Garnet Mountain if you like, just for a little climb, and to see the crude garnets that crowd the rock, just as they do in the similar mica schists of Manhatten Island, and in the region of Philadelphia. Or we can go down a wild canyon past some exquisite glacial lakes to the rock slides near the old Yancey Ranch. Here we will see the cony or rock rabbit, a dainty little rabbit just about as big as your fist; a colony of cliff swallows with their jug-shaped mud nests plastered on the overhanging rocks; past the historic Yancey Ranch buildings and back in time for dinner.

For birds and flowers we can go up the hill eastward, past the old Boys' School, over the hill and thru the flower gardens to the brink of Lost Creek canyon just behind this camp, up the creek to the big beaver dams, and perhaps see into an old deserted beaver house, over to Lost Lake, and back to dinner.

Practically no one ever sees the overhanging cliff properly on the way over here from Tower Fall. We might go over there. The best trip takes us up the road, while the dew is still on the grass . About a mile up we can turn into the canyon and go down to where the sulphur

holes and hot springs are found. We can see just how the rock is cooked into clay by hot vapors. This is a set of little thermal phenomena, man size, so we can play with them as much as we like. Coming out of the canyon we go on up to the overhanging cliff, past the big needle. At the cliff we can see just how the great lava flows poured down over the landscape, covering up everything in its way, and cooking the surface of the ground into ash and foam. We can follow this layer of rock-foam all along the roadside under the basaltic columns. Beneath this foam layer we find an unmistakable river gravel and river sands, so plain that a child can see what has happened. Evidently there was a river along the flank of the old volcano, and this eruption buried the river and put it out of business forever. What was the river and where did it come from and where did it go? There are pebbles in the gravel that do not look like anything from this region. We are waiting for some geologist to come in and explain it.

From the overhanging cliff we come home over a trail made by the boy scouts, thru two miles of the most glorious flower gardens one could desire, and back to the camp for dinner. One day a lady kept track of the flowers on this trail and counted 42 kinds.

If you are a seasoned mountaineer and want to see elk we can take an all day hike to the summit of Prospect Peak just back of Camp, and 3,000 feet above us. Total height 9300 feet. This is a long, hard climb; there is no trail, we just go up. At about 8,000 to 9,000 feet we see the female elk and calves. Failing that we may see some bull elk at the top. And sometimes we miss them entirely. The flower gardens

on the way and the alpine marsh near the summit are wonderfully rich for the botanist. We should leave by eight thirty and cannot be back before five in the afternoon. It is hard work even for the seasoned climber, but glorious and I would like to go.

Then there is Junction Butte from which you can see all of the region beyond, the beaver dams near Yancey's, and so on and so on.

This evening after supper we will go over to the beaver dams by the Petrified Tree, two miles up the auto road, and sit on the bank and watch the beavers swim about. Some people say they watch the beavers work. I only say swim about. We cannot hope to see them building dams or houses. But so far they have never failed to come out and put on some kind of a show. It is different every night. I will be glad to go over with anyone who wishes to go. We leave here at ten minutes to seven, and get back at about nine fifteen. It is 2 or 2½ miles each way on a good road.

Now if I have left unsaid just exactly the things you wanted me to say, please be free to ask questions, and I will tryto answer them. Yes, there is lots of good fishing. You can get fish almost anywhere if you know how. Generally speaking the nearer places are fished out first. Personally I do not fish and don't know nor care anything about it. ASK the fishing guide at the camp.

For further information about many things you can get the government pamphlets at the desk for ten cents each, one on the petrified forests,

one on geysers, one on geological history. At the Information Office at Mammoth you can get many other publications. For flowers and trees you should have Thone's little book, Trees and Flowers of the Yellowstone. For general information get Chittenden's History of Yellowstone Park, Skinner's Natural History or Bear book. And please use the ranger service in any way that you can. This service is absolutely free. You are our guests.

There's the dinner call -- and I must be after mine too. See you at 6:50.

# SOME YELLOWSTONE PARK BIRDS

Camp Roosevelt Evening Entertainment — Dr. H. S. Conard.

Revised to date and approved by: — May 30, 1926.

Superintendent H. M. Albright,
Mr. E. J. Sawyer, Park Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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Many people find that there are much fewer birds in Yellowstone Park than they expected. That is partly because of the general altitude, and partly because one does not see birds anywhere in wild regions without going off of the beaten trails where people are abundant. To see wild birds people must go alone in the quiet fields and woods, and preferably in the early morning.

But it will also be found that there are fewer birds in the region of coniferous or evergreen woods than in the region of deciduous forests. For one thing the coniferous forest is made up of fewer kinds of trees. Here we have many miles of unbroken lodgepole woods, for example. That in itself is unfavorable for variety, because there is no variety in habitat or food. Pines offer nothing to seed eating birds unless they can dig the delectable kernals out of a pine cone. The nutcracker crossbill, and pine grosbeak can do that. Then, the pines are not infested with as many kinds of insect pests as are the deciduous trees. One or two kinds of insects do fearful damage to our conifers. Witness the ravages of the sawfly near West Yellowstone and the bud worm beyond Garnet Mountain, and right in back of our camp here. But that does not give variety of food for variety of birds. So, no doubt, there are fewer birds, both fewer kinds and fewer individuals, in Yellowstone Park than

in a similar area in the central part of New York State. But if you wake up at daylight or are awakened, you will hear a chorus of song that loudly denies the suggestion that birds are scarce. They are really abundant. And 203 species have been seen by experts from time to time. I am no bird man - never was - but my list for two summers numbers 56 kinds. Let's go out tomorrow and see how many we can spot.

To mention some of the most striking of the park birds, let us begin with the largest and proceed to the smallest.

The largest birds in the park are the white pelican, Canada geese and the eagles, golden and bald. The golden eagle is a huge creature with six feet spread of wings. A bald eagle was accidently caught last winter in a coyote trap on Hellroaring Creek, right over here. The wings and tail of a golden eagle caught in a similar manner and which finally died, may be seen in the Museum at Mammoth. It weighed twelve pounds, as big as a good sized turkey. Such a bird might pick up and carry away a young lamb. But does it? Bailey says that the food of the golden eagle is mostly rodents which it catches alive. Under stress of circumstances it will attack domestic animals. And as the traps show, under still more severe stress it will stoop to eating carrion. You are not likely to see a golden eagle. I have never seen one in the wild.

The bald eagle is fairly common on the shores of Yellowstone Lake. He has been so beloved as our national bird that he has been all but exterminated within the United States proper. He is more common in

British Columbia and in Alaska than elsewhere, and a movement is on foot among conservationalists to protect the eagle in Alaska and Canada, so that he may not vanish from the earth. This is the way we treat the wild things that we like the most. We shoot our fine game animals and birds until they are about gone. We gather our favorite flowers until the place thereof knows them no more. Too much of our loving, even in the human domain, consists only in a desire to possess. When will we learn that children and wives and husbands and beautiful flowers and all of the graceful and glorious wild things of earth can give us real pleasure only so far as we delight in their own full free life and self expression. It is more blessed to plant a flower bed than to pick a bouquet. It is more blessed to leave the wild flowers for others to enjoy than to destroy even a few. Isn't it?

"Bird wing and flower stem -
Make them, who could?
Bird wing and flower stem -
Break them, who would?"

The "eagles" that you see in the canyon, and which have a nest in the Gardiner canyon on the famous Eagle Nest Rock are not eagles at all. They are ospreys or fish hawks, a related but a very different bird. Sorry. The bald eagle catches some of its food but prefers to eat dead fish and carrion. Rarely he catches fish for himself, but he prefers to let the osprey do the difficult job. Then, as the laden osprey flaps his way home, the bald eagle dashes at him from above, the osprey helpless, drops his fish in order to escape, the eagle dives and catches the fish in mid air and goes off to <u>his</u> home. He is a dastardly robber, stealing from the brave but peaceful neighbor, jumping on him from the back when he is loaded with game, - or perhaps living on carrion. Such,

unfortunately, is our national bird - a fit emblem of our imperialists in the opinion of our South American neighbors and the Filipinos. Is there any ground for their feelings? At any rate, it is our first duty to dispel any such opinion of the American people, and it can not be dispelled by force or exploitation.

The osprey is the big bird that you see nesting on the pinnacles in the Grand Canyon. There is a nest in an old tree down by Garnet Mountain. They build on the same spot, year after year, till the pile of sticks becomes as much as 5 feet in diameter, and five or six feet high. Two or three chicks hatch in this nest, and here they are fed on fresh fish. What an experience it must be when the fledglings make their first flight-launching out on untried wings from an inaccessible needle a thousand feet above the raging river! The slender wings of the adult stretch five and a half feet, and yet when we see them in the Canyon they look but little larger than a pigeon. That will help us to appreciate the unrealizable stupendous size of the Canyon itself. What relation is the fish hawk to the eagle? Well the old Park manual gives four families of birds of prey: the eagles, the broad-winged hawks in one family; next the falcons; then the fish hawk or osprey in a family by itself; then the owls. Mrs. Bailey includes the fish hawk in the same family with the hawks. At any rate the eagle and the osprey are very different birds, and it is usually only the latter that we see, all of the gearjammers to the contrary notwithstanding.

Our largest hawk and the commonest hereabouts, is the redtailed hawk, generally called the "hen hawk" in the east. Ours here is the western variety. It is the big bird that soars and circles in the sky going up

or down without apparent movement of a wing. There are several nests not far away. Last summer we saw a mother bird at Overhanging Cliff carrying a freshly captured ground squirrel. The baby was in an old tree just below us. The baby was afraid to try to fly and the mother was afraid to come so close to uss After most of us had gone away the baby ventured far enough to make connections with the dinner. The redtailed hawk is very much like its western cousin the Swainson hawk. The latter does not have the red tail. You can often see the tail gleam in the sun as the bird turns and tilts. But the young redtail has not a red tail either for the first year or two. So for my part I cannot distinguish a young redtail from a Swainson. I hope you can. The call of the redtail is a hoarse, sharp scream (imitate).

We see a good many desert sparrow hawks. To me they look just like any other sparrow hawks, and they behave the same. They poise in the air on fast beating wings, to pounce on some stray grasshopper, or sometimes a small bird or a mouse.

Then the great horned owl lives here too. I hear him from the hill in the middle of the night: Hoo-o-o-o, hoo, hoo, very deep and hollow (imitate).

The water birds certainly come next in size. At the Lake you see the gulls, and if you take a boat to Molly Island, you can see what I have never seen, the famous colony of white pelicans. In our little lakes about here the mallard duck nests. At this season we often see the old birds steaming out to sea, followed by a mosquito fleet of young duck-

lings, perhaps a dozen. They are recognized by the full brown color of the female and young, and the gorgeous green head of the male. In the Bird Lake beyond the Butte we find a few Barrow golden-eyes. The male is easily recognized by a large white patch on the side of the head. In this same lake is seen the coot or mud hen, so common all over the continent. He has almost black plumage and an ivory white bill. As you go along the shore of the lake, you hear the loud croaks of the coot, hear a splashing in the rushes, and shortly see a little black gunboat steaming rapidly out into the open water. Grebes are not rare. I once saw a baby one crying for lonliness and fright in the Yellowstone River at Tower Fall. The little fellow was lost from home and was drifting rapidly down stream in the furious current. I wonder if he ever got to shore. Probably some hungry coyote or oversized trout snapped him up.

In August many a lake has a great blue heron - sometimes two or three. This majestic bird stands 3 or 4 feet high, in shallow water, with his long, sharp bill poised, ready to spear an unwary frog, tadpole or salamander. His coat is mainly of a dull blue gray. I wonder where he comes from in August. Soon after the great blue heron has appeared we may look for the Canada goose. This truly magnificent bird is seen along the Lamar River, and the lakes beyond Junction Butte. The first I ever met were near the mouth of Soda Butte Creek, on the 13th of August, 1924. My small boy and I were sleeping on the ground under the great, starry canopy of heaven. I saw "the great star early droop to rest in the night", saw the brilliant constellations, saw the late moon drifting westward, woke in the morning and saw the hoar-frost all over the grass and on my

pillow, and heard the strange unmistakable honk of the wild geese. Last summer, 1925, 150 or more of these fine birds were visited at a lake near Lamar Bridge on our way down from Specimen Ridge. Like everything else in the park, they are much tamer than elsewhere, - but none too tame yet.

Perhaps next in size to the water birds are the crows and ravens and their kin. The crow and the raven are difficult to distinguish unless you have a keen sense of size. The raven is much the larger - half as large again. The raven soars when he flies, going long distances without flapping, also the wings show more slender than the crows, as related to their length. The crow is a flapper. The crow emits the well known "caw caw". The raven has a deep hoarse "walk walk" (imitations). Both eat anything that comes to hand - or to bill. They both frequent the bear dumps, or rather the hotel and camp dumps. Both are common. The rangers at our station last year caught two young crows in a nest long before they were able to fly, and raised them by hand. They became very tame and were the source of much entertainment. Tony was especially tame and friendly and inquisitive and mischievious. One day he went over to the window sill and picked up a needle for the victrola, flew with it to the machine - but I interfered before he had time to put it in place! Another day he came in to the house, picked up a little box of tire valves and carried them out and laid them down on the running board of the car. A man once gave him a dollar. He carried it over to the top of the barn and examined it. Finding it of no further use, he brought it back. He was not so welcome in my cabin. One evening he flew in as we were getting supper, right over the table and dragged his feet in the whipped cream on the desert. Another evening he rode on my shoulder over to

the beaver dam to see the beavers swim about. He sat with us in a very well behaved manner. It was dark when we started home and I carried him in my hands. Tony didn't like it. He cawed. I said, "No, Tony, you must ride home." I am afraid you would get lost." Tony rode a little farther, then he looked up at me very crossly, cawed fiercely and bit my hand. I told him he couldn't go. Then he cawed again, savagely - he has a lot of expression in his voice - and bit me just as savagely. Whereupon I threw him upon the ground. He flew a few feet with us and then flew up and disappeared in a big Douglas fir tree. I didn't dare report at the station that Tony was lost, two miles away. He had never been anywhere so far away before. But the first thing I heard next morning was Tony's familiar voice. He was a downright nuisance, but a most diverting pet. His parents used to come to the neighboring trees and he would go up and visit them, but they always separated again.

Nearly related to the crow is the Rocky Mountain jay, or camp robber. This is a medium sized, pretty, gray bird, the size of a large blackbird. He flies very quietly but has no fear of man, at least very little. He is the fellow that will fly down on your breakfast table, snatch a pancake on the wing, go up to a nearby tree, transferring the cake to his bill as he flies, so as to be ready to alight tracefully. There he will cock his shiny black eye at you while he enjoys the pancake, and gets ready to do it again. A very similar bird as to size and general outlines is the Clark nutcracker. Both have a harsh cry, but the cry of the nutcracker has a rattle in it, and he lives higher up in the mountains in the summertime. You see him on the way down

from the top of Mt. Washburn and along the main line. He has conspicuous white patches on his wings when he flies. He is gond of a drink, and will dive at terrific speed down a precipice to the river below, pulling up gracefully at the bottom, and perhaps once or twice on the way. He feeds his young on selected kernals of pine seeds, preferring the whitebarked pine. So he has to live at high altitudes for that pine rarely appears below 8,000 feet. He is a handsome bird and common. In September he comes down to this level for the winter. The magpie is less common here in summer than in winter. And yet you may have seen him abundantly on your way thru North Dakota and Montana. He has a very long tail and a large white patch on each wing; a large bird with a rough voice and rougher habits. He will eat anything that comes to hand. Occasionally one of these birds gets a taste of blood and becomes a really wicked and cruel monster. Up at Upper Soda Butte, and near Cody, you may see the big, handsome, crested, blackheaded jay. He is rare here and most resembles the jay of Colorado. The eastern blue jay does not come this far west, and the Oregon jay does not come this far east.

We have many woodpeckers. Everybody from east of the 100th meridian must see our red shafted flicker. There the eastern flicker has a yellow sheen on the under side of the tail and wings this one has a salmon red sheen. He is a handsome fellow. Otherwise he is exactly like the eastern bird; same voice, same size, same habits. In western Iowa and adjacent Nebraska and South Dakota the two forms dome together. Occasionally a bird is taken that is intermediate in character between the two, and it is believed to be a cross. But I cannot find any re-

cord of a pair of mated flickers of which one is red shafted and the other yellow. Until this is observed, the hybrid theory must remain only a theory. Maybe this difference is due to climatic causes or something of the sort. A pair of flickers nested last year (1925) in a hole in an aspen tree in the ranger station yard, just around the hill. We watched the whole process. The young were already hatched when I came on June 27th. Around here the rednaped sapsucker and western hairy woodpecker are sometimes seen.

Right now, out against the evening sky we might be watching the marvellous flight of the night hawk. He is so much like the eastern night hawk that only a specialist, with a bird in hand can tell the difference. He is recognized by the fact that he flies with the skill and swerving motion of a bat at twilight. But in addition he has very long narrow wings, and on the under side, our side, he has on each wing a white spot that looks like a hole in the wing. He is a good mark for a rifleman. You can always be sure that you have shot him thru the wing. He is closely related to the whippoorwil and has the same enormously wide mouth, so that his lower jaw seems to include the entire lower half of his head. Around the corners of his mouth are long bristles and with these he sweeps thru the air gathering in all of the gnats and mosquitoes he can find. At times he will drop like a shot from the sky at prodigious speed for a few hundred feet, then as he turns suddenly up again in a splendid parabolic curve, his wings cut the air with a deep boom(imitate). It is real sport to watch the nighthawks on a hot summer night, and see them swoop and boom. Of course he is no hawk at all. The nest is on a bare rock or the roof of a house will do, with no sticks or marks whatever.

We used to have pebble roofs in Philadelphia and that just suited the nighthawks.

The Yellowstone killdeer is just like the eastern one. The western mourning dove is like the eastern to you and me. So is the western robin and the western spotted sandpiper. The western meadowlark looks just like the eastern, but he has a ripple in his voice. Some like one better; some like the other. In central Iowa both are heard, but the western is more common.

The blackbird of this region is a little fellow known as Brewer's blackbird. The male has a splendid glossy coat, and the female is, as usual, duller. These birds may be seen almost any day on the lawns at Mammoth, and also about here. They flock in August and fly away. At the bird lake beyond Junction Butte the redwinged blackbird is found. This is called the thick-billed redwing blackbird, having some technical differences from the eastern kind. But it sings just like the eastern.

On a flaunting flag the red-wing sings
("Onk-o-lee!")
And he dips and sways and tilts his wings
To a rollicking south wind as he sings
("Ka-lonk-o-lee!")
One, two, three,
Nestlings hid where none can see.
("Ka-lonk-o-lee!")
(Weeks)

In the same bulrushes with the redwings is a colony of yellow headed blackbirds. This showy bird has white patches on the wings instead of red and yellow, and the male has a bright yellow head and neck. He is a real sight to behold. You will find him in Wisconsin (John Muir tells of seeing him), in northern Iowa and in Minnesota and from there to Utah

at least. If you do not know him, it is worth the hike to the lake to see him. There is only one well known colony of this species in the park, so I am told.

Probably the most beloved bird in the park is the water ousel or ousel, made famous by John Muir's writings from the Sierras. The ousel is a strictly western bird. It is about the color of the catbird, between the size of the sparrow and the robin, and with a very short tail. But its most striking characteristics relate to its behavior. It inhabits waterfalls or fierce rapids, both in our own Lost Creek back of the Camp, in Tower Creek, and in the Yellowstone. One pair mopolizes a stretch of the stream and no other ousel is allowed to remain in those preserves. When resting on a rock the ousel is always courtesying like a well trained English or German child. It isn't a bow or a teeter; it is a quick stoop and rise again (imitate). It does this about every five seconds. Then it steps down to the edge of the water and pecks in the rushing stream for its food. Not finding what it wants, it will walk right down under water, in a current that you or I would not dare move in, run adong the bottom, pick a mouthful of food and dart out on another rock, shake himself, and look as good as new. This is easily observed by anyone who has a bit of patience. You can sit for a few minutes or hours in the canyon in back of the Camp, or under the road bridge at Tower Fall. Some of our guests have had the time of their lives on these expeditions.

The ousels stay in the Park all of the year around. They begin to sing in December, and select their mates in February, Nesting begins in April. We have here, therefore, a bird which has a real married life, and not a

mere mating. The nest is built in a rock in the torrent, or under the overhanging curtain of water of a waterfall, or on the brink of a fall. Last summer my younger daughter found the nest on a big rock just at the top of the Lost Creek Fall. It is a hard climb to get there, but she saw the little tuft of moss and grass and saw the baby bird put its head out on one side of the tuft, and saw the parent bird give it food and fly away again. In 1924 there was a nest on a girder underneath the bridge at Tower Fall. At that place a lady watched the baby bird getting its first lesson in flying and hunting food.

Of smaller birds there is a goodly number. At Mammoth you see the Cassin purple finch, a sparrow-like bird with a rich red head. Almost everywhere in the park is the pink-sided junco, a gray bird with white feathers on each side of the tail, and very like the junco or snow bird of the east. The white crowned sparrow is common, easily recognized by the conspicuous white top of the head. The western chipping sparrow nests here and is common. The bird you are all wanting me to mention is the western tanager. It is rather larger than sparrow size, but the face is bright red and glossy, shading off to bright yellow and on back and sides, accentuated by black wings and tail. The western tanager - yellow, red and black where the eastern scarlet tanager is all red and black - a friendly, lovely glint of feathered sunshine, seen almost anywhere over lower elevations in the park.

And then you wanted to know about the mountain bluebird, perhaps

the commonest, brilliant bird in the park. The male is brilliant blue all over, except paler below from legs to tail, without the red breast of the eastern bluebird; they are closely related tho, different species of the same genus: Sialia sialis the eastern and Sialia curruccides the western. Bluebirds nest all around here, usually in a hole in a tree. Later in the summer it is a joy to see the families out learning to fly and catch bugs. The young and the females are not quite so gay as the males, but good enough. On my first visit to Excelsior Geyser, we noticed the bluebirds flying in and out thru the steam of the great spring. On watching for awhile we detected a nest on a shelf of rock within the edge of the old crater - a modern bluebird, raising her babies by the incubator method. But the Wilson phalarope has that quite beaten. This little bird looks somewhat like a sandpiper, but it swims like a duck. One day I saw a whole fleet of them on the first lake beyond Junction Butte. In this sub-family the female lays the eggs and then forgets about them. Mister incubates the eggs and cares for the babies; the last word in modern domestic felicity. Corresponding with this habit, the female is the more showy bird, and the male dresses in drab. Just the reverse is the rule with all other birds.

The song that we hear more than any other, especially in June and July, is the song of the golden Crowned Kinglet. The bird is about as big as your thumb. In the east it is a migrant in the spring and fall. Here it nests. And the thing I cannot understand is how so tiny a sprite can make so far-sounding a song. But it does, and apparently without effort. Then we also have a chickadee, the mountain

chickadee, like the eastern one in all of its cunning ways, but with a white stripe over the eye and a black stripe thru the eye. It investigates all of the twigs, hangs on wrong side up as cheerfully as right side up, and lives the merriest kind of a life. Its miniature dignity is best portrayed in a few verses by my old friend Dr. Leroy Titus Weeks, president of Tabor College, Iowa.

"The chickadee tilts
On a sycamore bough.
In cute little kilts
The chickadee tilts,
Like a brownie on stilts
Near his sweet little frau.
The chickadee tilts
On a sycamore bough.

"The chickadee wears
A cunning black cap.
In all his affairs
The chickadee wears
With genial airs,
The dear little chap, -
The chickadee wears
A cunning black cap.

"The Chickadee nests
In a hole in a tree.
The cats are not guests
Where the chickadee nests;
No robber molests
His little tepee.
The chickadee nests
In a hole in a tree.

"The chickadee dines
On what do you think?
Not ices and wines;
The chickadee dines
On lunches he finds
In many a chink.
The chickadee dines
On, - what do you think?

"The chickadee's song
Is "chickadee-dee".
Its not very long,
The chickadee's song,
Not much in a throng,
But it satisfies me.
The chickadee's song
Is "chickadee-dee".

(Stanzas transposed for elocutionary effect).

THE NATIONAL PARK SERVICE *** A SHORT GENERAL LECTURE

Ranger Marguerite Lindsley.

Approved by: April 15, 1926.

Superintendent Horace M. Albright,
Dr. H. S. Conard, in charge of the ranger-naturalists.
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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The National Park Service. What does that mean to you? In reality it is a great organization of red-blooded Americans who guard and protect your playgrounds. Playgrounds, that is what the national parks are; areas set aside for the "benefit and enjoyment of the people".

The National Park Service is only ten years old. Yes, there were national parks before that, but they were administered directly by the Secretary of the Interior, and several, including Yellowstone, were policed by detachments of the regular United States army. For thirty years out of the fifty-four of its existence the superintendent of Yellowstone National Park was the commanding officer in charge of the troops stationed at the cavalry post, Fort Yellowstone, near the north entrance of the park.

Soon after the act of Congress creating the National Park Service, Mr. Stephen T. Mather resigned his position as Assistant to the Secretary of the Interior to become its director. Director Mather is a white haired gentleman, erect and with very blue eyes, - the kind of eyes you find in men who have spent their lives seeing skies, seas, mountains and all out of doors. His interest in the national

parks is a very personal one. He gives all of his time to them. Morning, noon, and night he is planning for them; in his office in Washington or traveling from one end of the United States to the other and from Alaska to Hawaii. One of his chief amusements is to be taken for an ordinary ranger. On a hot, dusty August afternoon I saw him standing in the middle of the road at Towel Fall in the Yellowstone, - directing traffic. Once in awhile he stopped a car to ask the occupants if they were enjoying their trip, if they liked the park, or if the rangers were giving them good service.

Since 1915 when Director Mather first became interested in national parks he has been instrumental in having set aside seven of the finest of the nineteen. Rocky Mountain in Colorado, Hawaii, Lassen Volcano in California, Mt. McKinley in Alaska, Grand Canyon in Arizona, Zion in Utah and Lafayette, which, by the way, is the only park east of the Mississippi at present.

Director Mather's bureau, the National Park Service, has jurisdiction over more square miles of territory than six times the size of the State of Delaware, more than 13,000 square miles, all national parks or national monuments. National monuments are smaller than national parks usually, being set aside to preserve a single object of interest or a small area of land such as a prehistoric cliff dwelling or an exceptionally unusual geological phenomenon.

All other federal lands may be and are, developed commercially. National parks are great natural museums, to be preserved in their

original state; the flowers, trees, birds and animals to be protected and cared for. Last year the national parks were visited by more than two millions of visitors, - perhaps there will be three million in 1926. These people must be cared for, accommodations provided, their health guarded, protected from accident, furnished entertainment and educational facilities, and at the same time the natural beauties of the parks must be protected and their objects of scientific or historic interest guarded. As Director Mather says, it "is a big job!"

And the man who is responsible in the individual park is the superintendent of that park. I use Yellowstone as an example because I know conditions there better than elsewhere and also because it is the largest and oldest of the national parks. Superintendent Horace M. Albright is another man whose energy, ambition and enthusiasm for the National Park Service and for Yellowstone is genuine and unbounded. He has his organization running smoothly all of the time, and that is no mean task, keeping track of the various departments and overseeing all that is done. If anything goes wrong he must be responsible. He attends conferences, exchanging ideas with the superintendents of other national parks, having at his immediate command all of the innumerable details in his own park. If a ranger makes a mistake the report goes to the superintendent. If an accident occurs the superintendent reports it in detail to Washington. He could easily have the title, "Chief Coordinator".

Other Departments of the Federal Government are cooperating with the National Park Service in Yellowstone.

The United States Weather Bureau (U.S.D.A.) maintains an important observatory station there.

The Bureau of Fisheries (U.S.D.C.) has a large fish hatchery at Yellowstone Lake.

The Public Health Service (U.S.T.D.) makes inspections of all sanitary conditions, testing drinking waters, installing disposal plants, controlling mosquitoes, etc.

The representative of the Department of Justice is an U.S. Commissioner, Judge John W. Meldrum. Judge Meldrum has been in Yellowstone Park in this capacity for 32 years and he says that business has picked up considerably since they allowed the cars in eleven years ago!

People who are traveling have to write home and tell the folks what the park is like and picture post cards tell the story with the least effort. Often 20,000 post cards are mailed from Yellowstone Park post office in a single day.

Since a malignant disease called "hemorrhagic septicemia", threatened to destroy the whole buffalo herd in a single season, the calves are vaccinated each spring, and that is done under the supervision of the Bureau of Animal Industry (U.S.D.A.).

Where there are forests, insect pests must be controlled and the Bureau of Entomology (U.S.D.A.) handles this.

All of these bureaus and departments make Mr. Albright's work more complicated and difficult, but he knows that with their aid the best results can be obtained.

And now we come to the ranger force, comprised of 87 men in whose hands lies the responsibility of the care of that great park. Two millions of acres and 87 men. Twenty thousands of elk, 900 buffaloes, hundreds of other animals, and 87 men. 35 in the winter time. More than half of the force, the temporary rangers, leave when the park season is over. That all means that the life of a national park ranger is far from the proverbial "bed of roses". During the season they ride horses or motorcycles, chasing speeders or looking for forest fires, as the case might be. They round up the buffaloes and for this they must have the most alert and the fastest horses available. A buffalo is never friendly and he often turns suddenly in his tracks and charges a man on horseback. Buffaloes sometimes appear very awkward and lazy as a tourist sees them on a warm sunshiny afternoon, with a good stout fence intervening; their ropy little tails switching at flies and their tiny black eyes hidden in the dark, curly hair of their faces. But they are probably the most to be feared of the park animals and their protection is at once a delicate and dangerous task.

Forest fires are not uncommon during the late summer when the trees and underbrush are dry and there are many electric storms. Sometimes in fighting fires the rangers have to go without proper food and water, sleeping on the ground in their smoked and charred clothing

when they can't stay awake any longer; for days fighting fires that rage on the higher plateaus away from the roads and trails, and even miles from water. Equipment must be brought in with horses. Horses must have trails cleared for them in some places, unbridged rivers must be crossed, water carried and trenches dug. Then, when apparently extinguished, a large fire will smoulder for days in the deep mat of dry pine needles, bursting into flame again in a slight wind.

The park is just as wild today, back away from the beaten trails and roads, as it was more than a hundred years ago when white men first visited it. It is easy to climb to the top of some mountain and look for miles in every direction, seeing nothing but more mountains, lakes, rivers, and forests. No roads, no trails, no visible signs of man's existance, just wild, untouched country. A world in balance -- equilibrium. Doesn't wilderness affect you that way? Does it ever make you realize your insignificance if you are feeling a bit too proud of yourself? And then if you are despondent doesn't it have just the opposite effect, making you feel better? Or haven't you ever been there? In the wilderness, I mean. If not you have missed something that you owe yourself.

Just 35 men in the winter, but animals do not require the constant attention people do. They can't ask questions! But hundreds of tons of hay are fed to the buffaloes, elk, antelopes, deer and mountain sheep each year, and this is done when the weather is the coldest and the snows are the deepest, and frozen hands, ears and feet are not uncommon, - the ranger is true to his trust, the park animals.

Snowshoes and skis make travel in the winter possible. Yellowstone Lake, 23 miles long, freezes over and the men ski across it, saving many miles.

Assistant Chief Ranger Joe Douglas is a man you'll never forget if you are fortunate enough to meet him. He can tell enough stories to keep you sitting up all night beside a campfire listening; true stories of his experiences. He is very active and as he goes skiing along he is always singing a little song, - no one can tell you what it is but he is always humming it, - unless he knows you are listening. One day when the thermometer registered something like minus ten, ranger Douglas started out across Yellowstone Lake to the Lake Ranger Station, fifteen miles away. He struck an air hole in the ice and broke thru. He was carrying his skis and they caught on the edges and kept him from going clear thru or he would have been lost. He finally managed to climb out alone but the minute the air came in contact with his clothes they froze solid with ice. His duty lay in being at Lake that day, so he skied the remaining twelve miles with his clothes frozen to him, - not exactly a pleasure trip.

A humorous experience comes to mind. At that it probably was not so funny when it happened! Another ranger was skiing along a very narrow trail above a frozen stream, when he turned a sharp curve and found that three or four (he has never been quite sure which) wild buffaloes, some of the so-called Mountain Herd, were coming toward him on the same trail. He <u>landed</u> on the ice of the little stream, turned around and traveling! When he went back later he

found it was not possible for a man to make the jump on a pair of skis that he had made and light running. A buffalo is very large and very heavy and this ranger said that they give the impression of a snow plow in deep snow, - except that the snow plow is hindered by it more than a buffalo.

In the winter the rangers keep close track of all of the animals and the indications of their general health. When one is found dead it is reported immediately to the Chief Ranger, with a statement of the apparent cause of death. Such predatory animals as the wolves, coyotes and mountain lions are killed, under the supervision of the Superintendent, so that their depradations will not affect the normal increase of the others. It is not the policy of the National Park Service to exterminate any of the animals but merely to keep in check their numbers so that they will not do too much damage.

Rangers have many wild animals for pets. Often they are rescued by these men, - young, sickly animals, deserted by their parents, or small animals left orphans by the death of their mothers. And full grown ones are often made pets too; for instance this winter, nearly every ranger station has a pet marten or a pair of them. One particularly well known pet was Bill the elk. Bill was raised on a bottle from a spotted, big-eared calf with knock knees, until he finally adopted the buffaloes for his playmates. One spring he followed some of them when they were being brought in to Mammoth to be placed on display during the season. Bill stayed with us for a long time. He must have liked Mammoth people and I know he liked their clothes. He

made the rounds of the clothes lines every Monday, eating Various things. At present there is a young buffalo known as "Grunt" at Mammoth, which is daily becoming more of a problem, being quite affectionate and demonstrative already to the point of knocking you down.

And why do these rangers stay in the Yellowstone? If you ask them they can't tell you. There are lots of hardship, - I have only told you of a few of them.

They stay because their hearts are in their work. It is the thing they are best fitted to do if it is the thing at which they are the most contented. They appreciate the dependence of those little animals. They see the havoc wrought in great forests by fire. They realize the responsibility of their jobs in keeping that country just as it is, they work hard and they gain satisfaction.

Last month I saw one of the younger rangers here on his vacation. He had not been away from the park for over a year, and he had not been home, St. Paul, for three. He had thirty days of annual leave due him and I saw him when one week of it was gone. He was already planning on getting back, wondering how his pardner was getting along out on their station alone, envying him!

In closing I will tell you how Chief Ranger Sam Woodring spent his Thanksgiving a year ago. The day was given over to a lion hunt, and resulted in the capture of one of the largest specimens ever recorded in the park.

The Chief and a party of others set out early in the morning with a pack of trained dogs. Within an hour after they had found the tracks of the big cat they had him treed. They hoped to make a capture rather than a killing and cut down three trees in trying to get their ropes on him. He waited each time until the tree started to fall and then leaped thru the air, over their heads, landing twenty or thirty feet away, running. Each time they were successful in getting their ropes on him, he clipped them with his teeth like so much twine. He traveled like greased lightening but could not keep it up long enough to lose the dogs. The experience must have been a real one and they hated to resort to their guns to bring the great, snarling cat from his tree. Now the skin is mounted in a most lifelike manner in the Museum at Mammoth Hot Springs.

All visitors who see it are reminded that hidden dangers still lurk in the shadows of the Yellowstone, dangers especially for those little hoofed animals that people so love to see as they leap to safety in the bushes along the roads or as they are found grazing in some sheltered nook away from the main traveled ways.

This has been very brief, - just a general talk on some of the things which seem to me to make Yellowstone National Park appeal so strongly to those of us who know it very well.

# READING UP ON THE YELLOWSTONE

**Francis P. Farquhar**
*Editor, Sierra Club Bulletin*

Books, Maps, Magazine Articles and Government Reports on Yellowstone National Park

**56 TITLES**

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# READING UP ON THE YELLOWSTONE

By Francis P. Farquhar

THE Yellowstone National Park is almost like a foreign country upon a first visit. It is full of strange and remarkable things—a vast museum with countless objects calling for explanation. There are so many astonishing sights on either hand that one is inclined to forget that just beyond, in the great back-country of the park, are still more wonders and even grander scenes than those along the beaten path. There is, moreover, a human history of the region, which, while brief as such things go, is nevertheless full of interesting episodes and many vivid characters. It is a good plan, therefore, to frequent libraries and bookstores before making a trip to the park.

For the benefit of those who may desire to go prepared with some definite knowledge of what to expect and a general background for their observations, the following lists are presented. They do not purport to be a complete bibliography, but for all ordinary purposes they should serve as a sufficient field from which to make selections. The first two sections comprise a well-balanced and easily obtainable library on the Yellowstone National Park. The supplementary lists contain a wide range of publications offering profitable and enjoyable reading. Most of the volumes can be found in the larger libraries, although a number are out of print. A few are much harder to find, but are included because of their interest or historical importance.

## A.—Government Publications

The first thing to do in reading up on the Yellowstone is to obtain the current government publications. Write to the *Director of the National Park Service, Department of the Interior, Washington, D. C.*, for the following:

1. *Rules and Regulations, Yellowstone National Park.* (Latest annual.) Free.
2. *Motorists' Guide—Yellowstone National Park.* Free.

Next, write to the *Superintendent of Documents, Government Printing Office, Washington, D. C.*, sending remittance by post-office money order, for the following:

3. *Geological History of Yellowstone National Park.* By Arnold Hague. 24 pages, illustrated. Price, 10 cents.
4. *Geysers of Yellowstone National Park.* By Walter Harvey Weed. 32 pages, illustrated. Price, 10 cents.
5. *Fossil Forests of the Yellowstone National Park.* By F. H. Knowlton. 32 pages, illustrated. Price, 10 cents.
6. *Fishes of the Yellowstone National Park.* By Hugh M. Smith and W. C. Kendall. (Bureau of Fisheries Document 904.) 30 pages, illustrated. Price, 5 cents.
7. *Panoramic View of Yellowstone National Park.* (Map, 18 by 21 inches.) Price, 25 cents.

At the same time it would be well worth while to order from the Superintendent of Documents a book that contains a number of fine illustrations of Yellowstone as well as of all the national parks:

8. *National Parks Portfolio.* By Robert Sterling Yard. 248 pages, including 306 illustrations. Bound in cloth. Price, $1.00.

Maps can be purchased from the *Director of the U. S. Geological Survey, Washington, D. C.*, or may be obtained from local dealers at a small advance over the government price. Of the following, the large map of the entire park is essential; the others may prove useful in providing knowledge of the adjacent region:

9. *Map of Yellowstone National Park.* Size, 28½ by 32 inches; scale, two miles to the inch. Price, 25 cents.
10. *Livingston, Crandall, Ishawooa, Mount Leidy, Grand Teton Quadrangles.* (5 sheets.) Price, 10 cents each.

## B.—Leading Books on the Yellowstone

Without question, the two most important books on the Yellowstone are:

1. *The Yellowstone National Park: Historical and Descriptive.* By Hiram Martin Chittenden. 350 pages, illustrated.
2. *Haynes' New Guide and Motorists' Complete Road Log of Yellowstone National Park.* By J. E. Haynes. 192 pages, illustrated.

If not found locally, these books can be ordered from J. E. Haynes, Selby and Virginia avenues, St. Paul, Minnesota.

General Chittenden's book was first issued in 1895 and has gone through several editions. It is well composed, and is the most complete and authoritative book on the park. The early history of the region affords many fascinating tales: the thrilling adventures of John Colter, the fabulous stories of Jim Bridger, the mysteries of

unknown trappers; the pursuit of hostile Indians; and the varied experiences of exploring parties. A comprehensive summary is given of the principal natural features: animals, flowers, forests, as well as the geysers, mud springs, terraces, and other curiosities.

*Haynes' Guide Book* is the result of many years of evolution in presenting the material in the most convenient form. It is one of the most satisfactory guide-books to be found for any part of the world, and has an advantage over most in being thoroughly illustrated with well-taken and finely reproduced photographs. Its reliability is vouched for by the National Park Service.

Next in importance among the general books dealing with the park comes:

3. *The Discovery of Yellowstone Park, 1870.* By Nathaniel Pitt Langford. 188 pages, illustrated.

This is Langford's diary of the expedition that resulted in establishing the Yellowstone National Park by act of Congress, March 1, 1872. Originally published by Langford himself in 1905, it has recently been reprinted by J. E. Haynes in uniform style with *Haynes' Guide.* The quaint sketches and early photographs of the original have been retained. The "discovery" party, composed of some of the most reputable citizens of Montana, was organized for the purpose of determining finally and positively whether there was any truth in the wild tales of spouting fountains, hot springs, mud volcanoes, and other hellish things. The leader of the party was General Henry D. Washburn, surveyor-general of Montana. Langford became, two years later, the first superintendent of the Yellowstone National Park. To Cornelius Hedges, one of the members of the party, belongs the distinction of suggesting that this marvelous region should be made a national park. Besides being an historical document of great interest, this diary is an entertaining account of an exploring expedition in which men of more than ordinary individuality came day after day upon new and unexpected features of the most astonishing character.

Another general book, found in most libraries and obtainable, is:

4. *Wonders of the Yellowstone.* Edited by James Richardson. 256 pages, illustrated.

This was first issued in 1872, and has appeared in several editions. The chapters are drawn from the official reports of government ex-

peditions and surveys by Barlow, Doane, and Hayden, and from articles contributed to *Scribner's Monthly Magazine* by Hayden, Langford, and Everts. As most of these reports and articles are now difficult of access, this book is very useful in making this material available. The chapter entitled "Thirty-seven Days of Peril" describes an adventure that received wide publicity in its day and may well be read with profit by present-day visitors who have a tendency to wander from the trail.

The scientific features of the park are covered very well by the government pamphlets already mentioned and by the references to more extensive technical works to be found therein. In the field of natural history there are several good current books dealing specifically with the Yellowstone region. They are:

5. *The Yellowstone Nature Book.* By M. P. Skinner. 1924.
6. *Trees and Flowers of Yellowstone National Park.* By Frank E. A. Thone. 1923. 70 pages, illustrated.
7. *Trees and Shrubs of Yellowstone National Park.* By P. H. Hawkins. 1924. 125 pages, illustrated.
8. *Birds of Yellowstone National Park.* By M. P. Skinner. 1925. 192 pages, illustrated.

### C.—Supplementary Books on the Yellowstone

The following books deal primarily with the Yellowstone region and provide a good variety of reading supplementary to the group already mentioned. There may be some difficulty in finding the earlier ones, but a search is well worth while:

1. *The Great Divide.* By the Earl of Dunraven. 1876. (Reprinted in 1917 under title of *Hunting in the Yellowstone;* edited by Horace Kephart.)
2. *Calumet of the Coteau.* By P. W. Norris. 1884.
3. *Through the Yellowstone Park on Horseback.* By G. W. Wingate. 1886.
4. *The Passing of the Old West.* By Hal G. Evarts. 1921.
5. *Maw's Vacation—A Human Being in the Yellowstone.* By Emerson Hough. 1921.
6. *On the Trail in the Yellowstone.* By Wallace Smith. 1924.

### D.—Books Containing Important Chapters or Sections Relating to the Yellowstone Region

The list of books under this heading could be expanded indefinitely, and only a representative selection is given here:

1. *Camp and Cabin.* By Rossiter W. Raymond. 1880.
2. *Nez Percé Joseph. History of the Nez Percé Campaign of 1877.* By General O. O. Howard. 1881.
3. *The Book of the Boone and Crockett Club.* Edited by Theodore Roosevelt and George Bird Grinnell.
4. *Vigilante Days and Ways.* By N. P. Langford. 2 vols. 1890.
5. *Our National Parks.* By John Muir. 1901.
6. *The Biography of a Grizzly.* By Ernest Thompson Seton. 1903.
7. *Wild Animals at Home.* By Ernest Thompson Seton. 1913.
8. *Your National Parks.* By Enos Mills. 1917.
9. *The Book of the National Parks.* By Robert Sterling Yard. 1919.
10. *The Cross Pull.* By Hal G. Evarts. 1920.
11. *Down the Yellowstone.* By Lewis R. Freeman. 1922.
12. *The Call of the Mountains.* By LeRoy Jeffers. 1922.

## E.—Magazine Articles

Since the discovery of its wonders, in 1870, there has been a vast number of articles on the Yellowstone region in all manner of periodicals. Many of the scientific articles have appeared elsewhere in reports or books, and many of the general articles have been superseded by fuller and better accounts. Therefore, only a few of the outstanding ones are selected for this list. Some of these have been reprinted in books already listed:

1. *The Wonders of the Yellowstone.* By N. P. Langford. In *Scribner's Monthly,* vol. 2, nos. 1 and 2—May, June, 1871.
2. *Thirty-seven Days of Peril.* By Truman C. Everts. In *Scribner's Monthly,* vol. 3, no. 1—November, 1871.
3. *The Wonders of the West. More About the Yellowstone.* By F. V. Hayden. In *Scribner's Monthly,* vol. 3, no. 4—February, 1872.
4. *Ascent of Mount Hayden.* By N. P. Langford. In *Scribner's Monthly,* vol. 6, no. 2—June, 1873.
5. *The Three Tetons.* By Alice Wellington Rollins. In *Harper's New Monthly Magazine,* vol. 74—May, 1887.
6. *An Elk-Hunt at Two-Ocean Pass.* By Theodore Roosevelt. In *Century Magazine,* vol. 44—September, 1892.
7. *Yellowstone National Park Game Exploration.* A series of articles by Emerson Hough in *Forest and Stream,* May 5 to August 25, 1894.

## F.—Government Reports

Most of the government reports included in the following list are out of print and are no longer to be obtained from the Superintendent of

Documents. They can usually be found in the larger libraries, however. They are valuable sources of information for those who wish to go deeply into the history and character of the park:

1. *Annual Reports of the Superintendents of the Yellowstone National Park, for 1872, 1877 to 1915.* In *Annual Reports of the Secretary of the Interior.* (Since 1915 these reports have been included in the *Annual Reports of the Director of the National Park Service.*)
2. *Annual Reports upon the Construction, Repair, and Maintenance of Roads and Bridges in the Yellowstone National Park, 1890-1918.* In *Annual Reports of the Chief of Engineers, War Department.*
3. *Exploration of the Yellowstone River in 1859-1860.* By Bvt Brig-Gen W. F. Raynolds. 1868. (*40th Congress, 1st Session, Senate, Ex. Doc. No. 77.*)
4. *Geological Report of the Exploration of the Yellowstone and Missouri Rivers, 1859-1860.* By Dr. F. V. Hayden. 1869.
5. *Report of Lieutenant Gustavus C. Doane upon the So-called Yellowstone Expedition of 1870.* 1871. (*41st Congress, 3d Session, Senate, Ex. Doc. No. 51.*)
6. *An Engineer Report of a Reconnaissance of the Yellowstone River in 1871.* By Captain J. W. Barlow and Captain D. P. Heap. 1872. (*42d Congress, 2d Session, Senate, Ex. Doc. No. 66.*)
7. *Fifth Annual Report of the U. S. Geological Survey of the Territories for 1871.* By F. V. Hayden. 1872.
8. *Sixth Annual Report of the U. S. Geological Survey of the Territories, for 1872.* By F. V. Hayden, 1873.
9. *Twelfth Annual Report of the U. S. Geological Survey of the Territories, for 1878. Part II.* By F. V. Hayden. 1883.
10. *Reconnaissance of Northwestern Wyoming in 1873.* By Captain William A. Jones. 1875.
11. *Reconnoissance of the Streams and Lakes of the Yellowstone National Park, Wyoming.* By David Starr Jordan. In *Bulletin of U. S. Fish Commission*, vol. IX, for 1889.
12. *Reconnoissance of the Streams and Lakes of Western Montana and Northwestern Wyoming.* By Barton W. Evermann. In *Bulletin of U. S. Fish Commission*, vol. XI, for 1891.
13. *Geology of the Yellowstone National Park.* By Arnold Hague and others. *U. S. Geological Survey, Monograph No. XXXII*, Part II. 1899. Accompanied by Atlas.

# NOTES ON THE FOSSIL PLANTS IN THE REGION OF CAMP ROOSEVELT

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Approved by: July 24, 1926.

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The fossil forests of Yellowstone National Park are the most magnificent on the continent. Added to their spectacular beauty is the story they tell of the world of yesterday, when the Yellowstone region as we know it was taking form. Looking back into the past, we can read much of this story of the ancient days before man lived upon the earth. For while the written documents which we associate with human history are lacking, there is yet a singularly complete chronicle of past events in the rocks and in the fossils buried with them.

We may well consider why the record of former plant life is so exceptionally well preserved in Yellowstone Park. Most of the trees of today, - trunks, branches, and leaves, - decay and fall to pieces shortly after death, leaving after a few years little indication of their existence. But some of the trees which lived here four or five million years ago still stand on the rocky slopes of the valley of the Lamar River; the winter snows drift over their roots; birds and bees fly about them on warm summer days; and we, climbing the side of Specimen Ridge or the hills west of Camp Roosevelt, may almost mistake these ancient giants for the stumps of recently living trees until we touch them, and find they are of stone. They owe their en-

durance through the ages to a process called petrifaction, which means "making into rock".

The first requisite for petrifaction is rapid burial, for unless a tree is covered almost immediately the wood will decay. In ages past during the period called the Tertiary, there were several great volcanoes in the Yellowstone region, one of which was located not far south of Camp Roosevelt. In addition to pouring out lava flows over the adjacent country, this volcano had periods of explosive activity during which great volumes of rock were blown into bits by steam and scattered on the slopes below. Thus it came about that the forests of the region near the volcano were buried in this pyroclastic material (clastic means broken, and pyro - by fire). The tops of the trees, which remained uncovered, have decayed or burned, but the stumps were protected by the gradually solidifying mantle of volcanic ash which enclosed them. At various places another forest has grown on the volcanic ash and in turn has been destroyed by another volcanic eruption; at Specimen Ridge more than twelve such forest layers can be seen, representing alternating periods of tree growth and destruction.

The second stage in the process of petrifaction was also associated with vulcanism, involving the circulation of hot volcanic waters through the pryoclastic rocks and the buried tree stumps. These waters gradually dissolved away the wood, leaving in its place a mineral known as silica. So slowly was this interchange of material effected that the detailed cell structure and annual rings of the wood are commonly preserved. There is no evidence that the process

of petrifaction is in any way connected with geysers. Stumps and wood fragments submerged in geyser waters may become incrusted with mineral matter, but the wood itself is not known to be changed into rock except where it is buried.

A third stage in the development of the petrified forests as we know them involved the uncovering of the stumps. Rain and wind through the centuries have worn away the comparatively soft volcanic ash, but the wood replaced by silica - silicified wood - has resisted the process of erosion, since silica is one of the hardest of the common minerals. As a result these trees remain, - sequoias, pines, and sycamores, - their roots still fixed in the ground, their tall stems rising toward the sky, just as if thousands of centuries had not passed since their branches swayed in the wind and the birds of an ancient Yellowstone summer chose them for nesting places.

Around the roots of these old trees, in the rock which was once the soil of the forest, a careful search may disclose the impressions of leaves. The leaf itself is not present, since so delicate a structure is rarely petrified. But the print in the fine volcanic ash shows the shape and nervation, and enables us to recognize such species as the chestnut, now living only in the eastern United States, the sycamore which ranges into the Middle West, and the sequoia of the Pacific Coast. None of these are found today within many hundred miles of Yellowstone Park. They are for the most part trees which live at lower altitudes and under conditions of higher temperature and rainfall than now obtain here. The element of change is apparent,

as it is in the study of earth history everywhere. And if the Yellowstone as we know it is different from that of four million years ago, when showers of volcanic ash covered the forests of sequoia, pine, chestnut, and sycamore, preserving them down through the ages for our pleasure and instruction, may we not expect that the Yellowstone of four million years hence will likewise present a new appearance? There may even be left in the rocks a record of our activities here which will tell future visitors to Yellowstone Park the story of the life and living conditions of our time.

(Signed) Ralph W. Chaney

# HISTORY OF THE YELLOWSTONE LAKE

Ranger Charles Phillips

Approved by: July 20, 1926.

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Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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To many tourists Yellowstone Lake comes as a welcome lull in the almost continuous excitement of the four-and-a-half-day tour, a brief relaxation, from the high emotional pitch that the wierdness and wonder of the region engender in responsive natures. Yet beneath its tranquillity and sylvan peace lies the record of a story scarcely less stirring than that of the volcanic era.

Yellowstone Lake, like most of the lakes in northern United States, is a child of the ice age. The Park was not covered by the continental ice-sheet but rather by an ice cap formed of the amalgamated glaciers that moved down from the mountains. For this reason the movement of the ice in this region was not in a general north-and-south trend as on the Great Plains but in a variety of directions determined by the topography of the country. One ice-stream coming down the present Upper Yellowstone carved out the broad, rounded valley occupied by that stream and the Southeast Arm and probably excavated part of the depression now filled by Yellowstone Lake. Another glacier from the northern Absarokas gouged out the valley of the Lamar and the Yellowstone River below Junction Butte. This glacier eventually advanced to a point just south of Livingston. Small glaciers descended the

slopes of Mt. Washburn mingling with the general ice sheet at its base. There was at this time no vestige of a canyon; the broad, rolling upland plains on each side of the present river had not yet been divided by the deep gash that now separates them.

When a more genial climate finally prevailed again and the ice streams began to melt back toward their sources, huge volumes of water accumulated in the lowlands and a great lake developed that filled the basin of the Yellowstone Lake and Hayden Valley with arms extending up the Pelican Creek and Upper Yellowstone valleys. The natural outlet of this lake would have been the old pre-glacial channel at Outlet Canyon south of the lake but this was still blocked by the ice cap on Chicken Ridge and the water rose to the 8000 foot level, overflowing at several points; at Grebe Lake and thence down the course of the present Gibbon; at Mary Mt. and down the present Nez Perce Creek; and from the Thumb down the route of the auto-road to Lewis Lake and River. This drainage was, in a comparative sense, only temporary for Outlet Canyon was presently cleared of ice and established itself as the permanent outlet, bringing the lake down to 7900 feet.

This, then, was the glacial Lake Yellowstone that was probably older at its death than the present lake is now. It stood 100 feet higher than the water-level today and its area was 310 square miles as compared with the 139 square miles of the lake that we know. The glacial lake was in reality double, the upper lake covering Hayden Valley and washing the base of Mt. Washburn, the lower lake occupying the basin of the lake today with arms reaching up into Pelican Valley and the

Upper Yellowstone. The "Narrows" occurred at the rapids where the Yellowstone River makes a right-angled turn to the west about three miles below the Fishing Bridge. This huge body of water drained thru Outlet Canyon into Heart River and thence by way of the Snake and Columbia into the Pacific. The Continental Divide at that time passed over Mt. Washburn, extending southeastward over Pelican Cone and down the crest of the Absarokas.

The records that bring the story of the lake down to this point are so clear that one does not need to be a geologist to read them. The topography of Hayden Valley with its meandering, ox-bowed streams indicates even to the casual observer that it was recently a lake bottom while the terraces at Terrace Point show as unmistakably the several levels at which the lake stood at different stages of its history. How the drainage shifted northward is till, however, a mooted question. Many explanations have been offered but none seems more plausible and surely none is more dramatic than that suggested by Dr. J. Paul Goode. (Bulletin of the American Bureau of Geography Volume 11 Number 2 June 1901 - "The Piracy of the Yellowstone" - J. Paull Goode).

The Lamar was a great river in those days fed by the ice sheets that still covered the mountains. While there was no Yellowstone River the stream whose remnant we call Broad Creek had cut a large canyon which had been further enlarged below Tower Falls by the stream that antedated the present Tower Creek. Sulphur Creek, probably larger than it is today but still a small stream, flowed down the southeast flank of Mt. Washburn. It would have naturally drained into Glacial Lake Yellow-

stone but a slight obstruction diverted it to the north and it found its way into the canyon of the ancient Broad Creek where that stream turned sharply northward (i. e. at the mouth of the present Broad Creek).

Since the close of the volcanic era the surface rocks in this region had been acted upon by the steam and gases from the heated areas below, decomposing them and reducing them to a clay-like texture. These soft, disintegrated rocks were easily cut by so small a stream even as Sulphur Creek and before long the gulch of the creek was undermining the low bank that held back the waters of the great lake. Once breached an ever increasing volume of water roared down the little gully and into Broad Creek which now became the tributary and the new river in Sulphur Creek canyon the main stream. Even today the similarity between the Grand Canyon below the junction with Broad Creek and the canyon of the latter stream is unmistakable.

With two outlets the level of the lake dropped rapidly. Shortly the surface of the water fell below the altitude of Outlet Canyon and the entire drainage was through the north outlet. This is one of the most extensive examples of such a change of drainage known and the only one where the flow was shifted over the Continental Divide.

At 7800 feet the lowering was checked by a zone of hard rhyolite, unchanged by thermal decays. The decomposed material had heretofore not presented sufficient resistance to the stream to develop a cataract, in fact, the Canyon has not been cut by the recession of a waterfall as have the gorge at Niagra or the Mississippi at St. Anthony, but

rather by the continuous action of a long, unbroken series of rapids. Now, however, as this wall of resistant rock came to light a true cataract appeared which rapidly deepened as the increasing fall of water wore away the clayey substance below. The passage through this zone forms the present Lower Fall.

The check offered by this barrier halted the formerly rapid lowering of the lake and a series of beaches show that it remained at this level for some time. Finally the tremendous erosive power of a stream that must have been many times larger than the present river prevailed and the lake began slowly dropping again. Presently another resistant zone was not less than half a mile above the first. Here the process was repeated and the drop over this second ledge is today known as the Upper Fall. When the stream had cut a passage through the upper wall the gradual falling of the waters above was resumed and continued without interruption until a third resistant region was uncovered.

This was at the "Narrows" of the glacial lake, i. e. at the rapids a few miles below the present outlet, and it held back the waters of the lake above until the Hayden Valley Lake was completely drained through the gaps that had been by this time cut in the two lower ledges.

This left Yellowstone Lake and River and Canyon as we see them today. The process is still going on but at an infinitely slower rate for the volume of the present river is a mere fraction of the river that carved the Canyon. Still, it is not difficult to foretell what their future evolution will be if the river retains even its present comparatively

weak erosive power. The hard rock supporting both the Lower and Upper Falls will be cut through eventually and in its place we will have a series of rapids and cascades as the river eats its way through the sand and silt of Hayden Valley. The rock at the rapids will resist erosion while the softer material in the river-bed below is being carried away, the water falling over the unchanged rhyolite in a cataract of constantly growing height. Presently we shall have another Falls of the Yellowstone, this time (unless an unforeseen ledge come to light) a single fall and twelve miles above the falls of today.

The fish life of the Lake offers a situation no less unique than its change of drainage and which in a way parallels it. Yellowstone Park is a volcanic plateau several thousand feet above the surrounding region and every stream that flows out of the Park has one or more falls in its course that carry it down to the lower elevation. For that reason the Park waters were barren of fish life until stocked by the Bureau of Fisheries after the creation of the national Park. The earliest explorers, however, noted that Yellowstone Lake and River, both above and below the falls, abound in a species of trout. This exception long remained inexplicable, assuming that the fish had reached the head-waters of the Yellowstone, as they normally would, from its lower reaches for of all the cataracts in the Park the falls of the Yellowstone would obviously be least surmountable. When it was observed that the fish were practically identical with the cut-throat trout of the Pacific slope an explanation was sought in other quarters. More thorough explanation revealed the fact that at Two-Ocean Pass, south of the Park, the headwaters

of the Yellowstone mingle with those of the Snake River of the Pacific drainage in a grassy alpine meadow on which the water often stands deep enough in spring, when the trout ascend their native streams to spawn, for the fish to cross from one side of the Divide to the other. This explanation was afterward completely verified by Dr. David Starr Jordan who observed trout passing from Pacific to Atlantic Creek. Then this last episode brings the history of Yellowstone Lake down to the present for while the first passage of fish over the Continental Divide occurred centuries ago, it is doubtlessly taking place, when local conditions make it possible, no less frequently today.

(Signed) Charles Phillips

# YELLOWSTONE PARK BEARS

The lecture given at Grand Canyon Hotel during the season of 1926.

By Temporary Park Ranger Elmer A. Hall Jr.

Approved by: July 24, 1926.

Superintendent H. M. Albright,
Park Naturalist F. J. Sawyer,
Dr. H. B. Conard, in charge of the Ranger Naturalists,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

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One of the many duties of the National Park Service, the guardians of the National Parks and Monuments of this nation, is "the interpretation of the Park's wonders". For this purpose a Ranger Naturalist Service was organized whose duty it is to guide the people around the more interesting points during the day and to deliver lectures at the various hotels and camps in the evenings. The Service is attempting to put before the visitors the important and interesting explanations of the different phenomena, the wild animal life, and a history of the Park, in terms which are readily understood by the average visitor. In this connection a short lecture has been arranged at Canyon on the bears, one of the most interesting studies in the Park.

The first thing that I wish to explain is that there are only two types of bears in Yellowstone instead of three as many people believe. They are the Grizzly and the American Black Bear. Many people put the brown and cinnamon bear in a separate class, but they are all members of the black bear family - "blondes and brunettes", so to speak.

In the early days of the Park hunting was allowed, and, as a result,

the bears never reached very great numbers. But in 1886 when the military took over the Administration of this playground all hunting was stopped. The bears soon learned that man meant them no injury, and that they were safe within the Park limits. I do not mean to have you believe that the bears know where the boundary line is, and that they walk up and down just inside, laughing at the hunters who are waiting for them to step over. That is too much of a bear story, like some of the fish stories our friends tell us. But many bears do wander outside each winter and are never heard of any more.

By 1889 black bears were to be seen on the different garbage dumps in small numbers. They came at night and were very shy and timid. In 1890 they became so numerous and troublesome that the Administration considered getting rid of them, but the tourists made known their interest in these animals so that it was decided to allow them to remain in their native haunts. On April 5th of this year, Chief Ranger Woodring, in an official report to the Director of the Museum, estimated that there were 200 black and 75 grizzlies in the Park.

Another misconception in the minds of many persons who are acquainted with the facts is the idea that all grizzlies are bloodthirsty, savage killers, attacking man or beast for no reason whatsoever. This is far from the true state of affairs as the grizzly has been found to be the more trustworthy of the two. The black bear is a big bluffer. The only trouble is that his bluff charge is liable to turn into a real charge at any instant. But with this characteristic trait of treachery, they also carry one of great curiosity. They are always investigating

new and strange things, especially the automobiles and camps of the tourists. Many tales are told of funny experiences that these people have with the bear-thieves.

They especially like ham, bacon, and sweets. Several years ago, a tourist at Norris tied what happened to be the major portion of his morrow's breakfast, a small slab of bacon, to a rope which he slung over a limb extending above his tent. A bear sauntering by that night on his customary nocturnal quest for food caught a whiff of that savory morsel. He climbed the tree and slipped out onto the branch over which the rope was slung. He was thinking more of the food than of the strength of the limb. It snapped, tumbling the bear onto the tent. The tourist was terrified and with a loud voice awakened everyone in camp. The bear was in as much hurry to leave as the tourist was to have him leave. In his hurried exit he scattered the furnishings of the tent in all directions making a nice mess of the camp. The tourist swore up and down that he had been attacked by a grizzly. He, did not know that a grizzly cannot climb trees.

Before taking up the life and habits of the bears, I wish to bring up a subject which causes us a great deal of trouble each year. I refer to the feeding of bears by park visitors. Many people do not feed them, but make them do tricks to get the food. This is considered molesting and teasing and is discouraged by the Park officials. It has often resulted disastrously for the person doing the feeding. I have just pointed out the treacherous trait in the black bear family, so I think that you can readily see that it is much safer to

leave them alone. There is plenty of food to feed many more bears than there are in the Park at present so they will not miss the small morsel that you could give them.

Every hotel and camp has its bear dump where the visitor can see the bears in perfect safety. A ranger is on duty at each dump to watch the bears and answer any questions that you may wish to ask him. I would also like to bring to your attention the fact that noise will scare the bears away. Many people come out to see the show on the bear dump and when they are satisfied and ready to leave they are usually rather noisy in getting their party together. They never think that the noise they are making will spoil the show for someone else. I would also ask you to refrain from waving handerchiefs when on the dump as that also will scare them. And so I wish to make two pleas to you and your friends. The first is to leave the bears alone, and the second, to refrain from noisy actions when approaching, leaving, or present at a bear dump.

And while we are on the question of feeding I shall take up the various foods that they live on. If one was to compile a list he would have to put down almost everything edible. The main source of food during the summer months is the garbage dumps of the hotels and camps scattered through the Park, bear dumps as they are called in Yellowstone lingo. Another source of food supply is the smaller animals such as mice, woodchucks, ground squirrels, and chipmunks. When driven by extreme hunger, a bear will attack a full grown elk or deer, but these cases are rare as there is too much food to be gotten in an easier manner.

When a bear does start to feed he hogs everything for himself. They seldome carry anything away. If a black bear decides to seek a better place to dine, he usually goes only a short way into a dense thicket which will hide him from the sight of others. The grizzly is known to hide the carcass of his kill, sometimes, but ordinarily they eat what they wish and leave the rest. Other articles on their menus are herbs, grubs, worms, berries, the soft inner layer of bark, ants, nuts, and fish, especially in Alaska. An Alaskan bear will lay for hours on the bank of a small stream with one paw hanging lazily in the water. With a sudden tensing of his muscles and sweep of his paw he will throw a trout from the stream and pounce on it before it can get away.

As I have mentioned before each hotel and camp has its bear dump. No doubt you will be interested to know what species and the approximate number you will meet at your different stopping places.

| | | |
|---|---|---|
| Mammoth | Small number | Black |
| Norris | " " | " |
| Madison | " " | " |
| Faithful | More Numerous | " with occasional grizzly |
| Thumb | Few | " |
| Canyon | Very numerous | " and grizzlies common |
| Lake | " " | " " " " |
| Roosevelt | " " | " |

There are also many bears back in the timber which seldom come out on the road or the dumps.

Another interesting thing about a bear is his mode of living. This must be divided into two parts: summer and winter. The summer life can be disposed of in a few short sentences. They have no regular home; a handy tree or thicket serves as their domicile when one is needed. Most of their time is spent in roaming around the vicinity of the garbage dumps

or panhandling along the road. The most interesting part of their life to us is that of the winter hibernation. Late in the summer they begin to grow fat and restless, making long trips for the purpose of finding a place for their winter sleep. It is seldom that a bear will occupy the same den two years in succession unless they can find nothing better. Grizzlies usually select a dry warm place at about 7500 feet altitude. If they cannot find a place ready-made, they will dig a hole in a slope. Blacks also select caves and in addition will hole up in hollow logs or under a heavy windfall. The time that they go into hibernation differs. It is affected by several things, such as climatic and food conditions. The usual time for them to go in is from the tenth to the twentieth of October, although some have been seen out as late as November first or even later. When they begin their sleep they usually have about three inches of long hair as protection against the elements, and four inches of fat which serves as food. When they awaken in the spring they look as fat as in the fall, but the fat has become spongy and is of no value. By two weeks after they have made their appearance, they have lost this spongy tissue and have a "lean and hungry look". Around the middle of April is the usual time for them to make their appearance, although they have been seen out as early as the latter part of March.

It is during the winter sleep that the young are born. The mating season is during June and July. They mate for two weeks and then separate probably never to see each other again. The species do not intermate except in very rare cases. The blacks breed every two years; the grizzlies apparently every three. The usual litter is two, but a one or three cub litter is not uncommon. At birth a black bear is about

nine inches and a grizzly about twelve. They open their eyes at the end of forty days, and start to walk at about two months. At the end of three months they have grown so that the black weighs about three pounds and the grizzly ten. They are usually weaned at the end of a year. The first winter after their birth they usually sleep with their mother, leaving her the following spring. The litter stays together for a year and hibernate together that winter, scattering to the four winds the next spring or when a little over two years old. The American Black Bear reaches maturity in three years and the grizzlies in eight, although the latter breeds when three and a half years old. At maturity the black weighs from three to four hundred pounds; grizzlies from five to six hundred pounds. Both species have been known to reach even greater weights as they grow older. Last year on the Canyon dump we had several grizzlies that we estimated to be around eight to nine hundred pounds and several that were even larger.

The average American Black bear is a glossy smooth-coated animal with a tan or brown muzzle; short black curved claws, incapable of being withdrawn without tearing; teeth composed of some sharp cutters and broad grinding molars, evidence of their two kinds of diet; small erect and almost hidden ears; a short and practically non-existant tail. They ordinarily stand twenty-five inches at the shoulders and about five feet from tip to tip.

The grizzly's coat runs from a silver-tipped fur to fur that is grey for two inches from the tip. Their claws are brown in color, straighter

than the black's and two or three times as long. They also have narrower foreheads and squarer muzzles. Their shoulders stand high giving them the appearance of saddlebacks. There is quite a distinction between the walks of the two types. The grizzly has a shuffling walk that carries an indication of great power, whereas the black looks clumsy and awkward, nevertheless bears of either species will outrun an average horse and will often travel forty or fifty miles in a day. Another big difference as mentioned before, is that blacks climb trees while grizzlies do not. Grizzly cubs, before their claws begin to straighten can scamper up a tree, but a mature grizzly cannot climb. All bears have very poor eyesight, but this is offset by their keen sense of hearing and smell.

In closing I wish to call your attention to the Museum which is located in the same building as the Information Office at Mammoth. The building is easily located by the pile of elk horns in front. Many interesting exhibits of different things in the Park, such as the wild animal and bird life, formations, etc., have been arranged for your enjoyment. Mr. Sawyer, the Park Naturalist, or one of his assistants is on duty at all times, and they will gladly escort you through, explaining the different exhibits.

I have been able to give only a few general remarks in this short time. One could talk for hours on this subject as each bear is a study in itself. If anyone wishes to ask any questions I shall be very glad to answer them if he will see me in the lobby after the program.

(Signed) Elmer A. Kell, Jr.